Reconsidering the Challenges of BIS Education in Light of the COVID Pandemic

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Abstract. So far, the biggest challenge for a comprehensive Business Information Systems (BIS) education curriculum was the fast-changing nature of its target market and the resulting demand for a combination of up-to-date technical knowledge, organization-centred mindset, and adaptive skills. However, advances in pedagogical methods, changes in the skills of high-school graduates, and widening online options in the wake of the COVID-19 pandemic brought on a new set of expectations. This situation may be considered an opportunity to address the threat of potentially increasing mismatch and misalignment between competences required by the IS industry labour market and current training contents offered and methods used by higher education institutions. This paper provides a systematic and comprehensive overview of the challenges BIS programs have to face and address. It considers everyday experiences of BIS educators and current best practices as starting point. Then provides an overview of employer and alumni opinion, as well as reviews up-to-date teaching methods related to teaching soft computer skills. It also considers the requirements and opportunities related to an increasingly online-centred situation. Based on these challenges the paper lays down the foundation for a potential curriculum design approach intended to address all of the above issues in an integrated framework.

Keywords: Business Information Systems · Higher education teaching methods · Online education · TOGAF · Curriculum design

1 Introduction

The academic field of Business Information Systems (BIS) is a complex area bridging business and organisational topics with questions of applied information technology. Teaching such a multidisciplinary domain which assumes not only knowledge of theoretical concepts and technical skills to use tools but also a problem centred mindset and related problem-solving abilities is a challenge in itself. However, with the heightened need for high-quality online education (offering both distance or blended learning options in the wake of the COVID-19 pandemic) educators of this area face increased difficulties to find appropriate methods and create new content and teaching material. Sharing ideas and experiences regarding what worked and what was less successful could enhance our knowledge of BIS distance education.

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Creating third level programs to educate professionals who are able to meet current and emerging expectations drew different answers from different stakeholders [1–3]. In fact, even the name of programs offered show some divergence: depending on native language, history, and culture, BIS-like education is offered under different names including: BIS, Management Information Systems, Business Informatics, Business and IT, Business IT, Business Computing, and so on. Beyond the names there are, of course, curricula offered with different goals and focus ranging from those closer to technology and computer science, through business analytics (or even data science), to more business focused options [3].

Over the last decade two trends may be observed in the demand for BIS graduates. On the one hand some employers, especially SMEs expect graduates who can take on responsibilities almost right away (i.e. having a wide range of specific skills including programming or use of certain tools), while other organizations (mostly large and multinational ones) expect newhires to be flexible, with convertible skills (as they will provide them with customized corporate training) [4, 5]. These demands add to the challenges of an already complex educational setting.

Therefore, to understand the full picture of BIS education of our days, this theoretical discussion offers a systematic overview of various challenges BIS programs need to address and concludes in a proposed integrated approach based on the TOGAF framework [6]. Therefore, this paper first looks at everyday experiences of BIS educators including current best practices. The third section then provides a discussion of challenges along the following dimensions: employer and alumni opinion about required BIS job skills, changes in abilities of incoming high-school students, latest trends in teaching methods, modern assessments techniques, tools and trends of online education, and the special situation highlighted by the recent COVID-19 pandemic. Based on these challenges the fourth section lays down the foundation for a potential curriculum design approach intended to address those issues. The paper closes with summary and further directions.

2 BIS and Its Education

2.1 Typical Characteristics of the BIS Field

The labour market where Information Systems professionals are employed may be characterized by the fast-changing nature of the jobs and the resulting demand for a combination of up-to-date technical knowledge and adaptive skills rooted in the project-oriented and teamwork-based reality of developing, implementing, and managing IT/IS solutions in an organizational context [7]. Beyond the obvious basics of the trade, interpersonal skills, team building and the ability to combine individual efforts with group work are an essential part of BIS professionals [8]. Employers value problem-solving skills and independence with the ability to learn quickly. On top of basic knowledge of IT and business concepts, a broad professional outlook, the right mindset and a systems approach is expected. A good level of English is a must these days.

BIS graduates are typically hired to bridge the gap between IT and business. This gap is especially relevant for large and medium sized companies, or for IT service providers. Typical business IT jobs include: business analysis, system development, digitization, presale activities, logical and physical design of IT services, database management, data analysis and data mining, IT demand management, IT project management, IT services financial controlling, application and service support, IT risk analysis, automation of business processes, and software testing. Regarding specialized IT-IS areas, the list ranges from artificial intelligence and its application, automation, autonomous systems, and process optimisation, to GDPR, cybersecurity, IT security, but industrial modernisation (industry 4.0), databases, BI and data visualisation are also strongly emphasised.

In IT related areas knowledge of the basics changes quickly. Knowledge gained during institutional training can quickly become obsolete, and technologies learnt can get outdated. It is an important goal for students to be able to learn independently, and be capable of self-driven, self-regulated learning.

2.2 A Brief Overview of Some BIS Programs Around the World

A comparative analysis of practices in BIS programs was conducted for 26° programs around the world (see [9] in this volume). They are offered by institutions highly ranked on the Times Higher Education World University Rankings list. These institutions are concentrated in Europe and mainly in the UK, but three are from Asia, two from Australia and one from the United States. 4 programs focus on Information Management, 8 programs are about Information Systems, 5 programs focus on IT, 5 are from the analytics or data science side and 4 covers business administration domain. 35% of these programs aims at focusing on how technology drives business.

Typical career paths at these institutes are business analyst, consultant, project manager and developer in banking, finance, IT sector etc. Companies are involved in not just hiring students as interns, but also in carrying out these courses. Interesting result was that project work was a quite popular methodology applied by these institutions Practice-oriented knowledge transfer is realized in this way. Some programs provide minor program besides major but other ones make their students specialized by elective modules. Their subjects go around e-business, data science, information systems auditing, artificial intelligence, digital transformation domain and so on. The typical length of studies is 6 or 8 semesters, but the total number of credits vary on a broad scale from 120 to 480. Practically, Anglo-Saxon institutes prefer providing programs with high total credits. Their courses usually have 15–20 credits and they put relatively small attention on foundation subjects (approx. 10% of total credits). It is quite common for all peer institutions that Information Technology and Manager Information Systems subject appear in the same degree in the programs.

3 Specific Challenges to Teach BIS

3.1 Challenges of Teaching BIS Arising from the Nature of the Field

BIS is a truly interdisciplinary subject and its education covers several fields – albeit in differing depths – and successfully applying them requires the understanding of their interworking. There are mathematical foundations (analysis, algebra, statistics) but it is also rooted in the basics of economics (e.g. macro and micro economic theories). It requires computer science (hardware, software, and network architecture and programming) foundations too, as well as knowledge of operating systems and various protocols. It also builds on organizational studies (including organizational functions, management, and production processes) [10]. Most importantly it has specific areas involving the application of all of the above, such as functional and enterprise systems, as well as systems development, deployment, and impact analysis. The main challenge for a comprehensive Business Information Systems education curriculum is the pace of-change in its target market and the resulting change in knowledge and skills requirements.

Beyond its multidisciplinary nature, pedagogically it is characterized by a typically high ratio of seminars, the need for project focus, and the requirement of working in groups [8]. BIS education in a classroom context - considering the Bachelor level - may be described by what the literature calls 'active learning' focusing on student interaction. For online options video and audio solutions are usually augmented with less synchronous means such as text messages or sharing files, this still does not make up for lost personal proximity. Using document sharing options and working on the same file together raises new challenges just as much as offering new opportunities. To be successful in this setting of increased complexity and expectations lecturers could use any help they could get - let it be experiences, best practices, successful methodologies, or even ready-made materials [11].

3.2 Global Generational Challenges to 3rd Level Education

Incoming students who arrive to a BIS BSc program show a strong character of digital readiness, even more than their peers in general. The accelerated evolution of our digital world fundamentally determines the life of our youth (even in less developed countries). They may be described being "phygital" [12], as in their world everything physical now has a digital equivalent. From physical reality they have moved to digital communication [13]. For them the real and the virtual is strongly coupled and forms a unity [14]. The continuous technological revolution leading to newer and newer solutions appearing with increasing frequency requires flexibility, creativity, and a fast adaptation to desirable behavioural patterns.

The available information is almost infinite, sources of information are countless and change fast. At the same time, the content of knowledge and the forms of teaching-and-learning (T&L) have also been changing. It seems that traditional forms of knowledge transfer have become less efficient [15]. Students acquire a growing portion of their knowledge from sources outside educational institutions. In the fast expanding informational space stimulus threshold (of attention) is raised, the youth longs for newer and newer impulses and information. The vast opportunity for quick information also makes them less patient. However, when it comes to making decisions they appear more uncertain and tentative despite their apparent confidence in getting information. They need outside assistance, guidance, and help with avoiding the temptation of constant interruptions to focused studying, because there is a steady influx of activity requests such as visiting webpages not related to the learning material, checking emails, visiting social media profiles, joining a chat, or simply playing games [16]. Due to the too high pressure coming from education institutions and teachers coupled with inadequate time-management skills this generation of teenagers has a higher tendency of mental problems than their predecessors had (for example, in the United States youngsters who have experienced some form of depression reached almost 60% in 2017) [16].

Today's high-school students expect relevant, quickly applicable knowledge from education institutions mostly covering technical literacy (such as math, coding, basic technical sciences), as well as data management and interpersonal skills (to be able to connect to others). They value system level thinking, creativity, and knowledge about human behaviour – preferably acquired through experience-based learning [14]. They expect different teaching methods and educational arrangements during their (mandatory) formal training. Their preference is increasingly shifting towards forms of active learning, that are based on gaining experience through practical exercises and require intensive communication [17]. At the same time, they constantly seek feedback, long for reassurance and expect rewards [18].

3.3 Availability of New Advanced 3rd Level Teaching Methods

Over the last two decades or so major changes may be observed in the pedagogical methods available to the university and college teaching community. Some of these are rooted in general new pedagogical approaches while others consider improvements to online options. And, of course, there is a clear drive to integrate them as well.

Problem based learning (PBL) has emerged from constructivist didactics and builds upon students' preliminary knowledge, expectations and interest. For this the starting point of learning is a problem or an issue to solve and students first get familiar with it before learning the information necessary to create a solution. The method is characterized by student-centeredness, work in small group, the presence of the teacher as a facilitator, and the work being organized around the problem [19]. The method incorporates the gaining of knowledge with the development of general skills and attitudes. It also promotes the development of numerous important soft-skills, e.g. communication skills, teamwork, problem-solving, independence, sharing information, and the respect of others [20]. Since one of the starting points of the method is taking the students' individual differences (interest, preliminary knowledge, etc.) into consideration, it is typical that students are motivated to work, spend much time on their studies and intensively take part in course work - especially if they also have an opportunity to have a say in defining the problem [21].

Inquiry-based learning (IBL) is a group of student-centred methods driven by inquiry or research [22]. According to Spronken-Smith et al. [23], IBL is used typically for teaching natural science subjects, where participants experience the process of knowledge creation, and discover the meaning and relevance of information through a sequence of steps. This way learners reach conclusions and reflections related to the newly gained knowledge. The method builds on the curiosity of students about the world surrounding them. Its aim is to develop critical thinking, increase the ability for independent research and raise awareness among students that they are responsible for their own learning, growth, and full maturity [24]. Ernst, Hodge and Yoshinobu [25] who examined the efficiency of the method in relation to the teaching of mathematics, emphasize the deep engagement in rich mathematics (and in general the topic) and the opportunities to collaborate (in some form) during problem solving. The claim is that during the application of this method students' learning performance increases, so does teachers' joy of teaching along with the number of teacher-student and student-student interactions.

The *flipped classroom* educational process model is a form of blended learning. During the application of this instructional strategy preliminary, individual processing of the material of traditional lectures takes place first (typically online), which is then followed by an active classroom work also incorporating problem-based, cooperative methods [26]. In the interpretation of Bishop and Verleger [27], during the preliminary preparation students process multimedia contents. According to Lo, Hew, and Chen [28] this method is based on the use of online technology such that video teaching materials (prepared in advance in short portions of 8–15 min) should be watched by students. Then actual classroom work is composed of short lectures as well as problem solving exercises (individually or in small groups). According to the creators of the model [29], watching the videos just before class is not enough for success. He finds that real information processing and learning should take place at home and students are to arrive to class with notes and questions, which are checked and answered by the teacher. Tucker [30] emphasizes the rethinking of all aspects of teaching and names 'best utilization of the time spent on learning' as the main goal of education.

In case of the so called '*mirrored classroom*' educational process students found their knowledge with their preliminary preparation, which is deepened by conversations during (in-school) classes, complex and cooperative tasks, and teachers' feedback. All these promote the autonomy and cooperation of students while matching students' individual needs much better [31].

Agile Teaching/Learning Methodology (ATLM) is designed for higher education by building upon the best practices and ideas from the field of software engineering. It utilizes concepts from agile software methodologies [32] which is based upon the observation that the processes of software development and learning are in many ways very similar: participants with different (sometimes clashing) goals work together until a certain deadline, based on a very tight schedule, possessing limited resources, and facing many expected/unexpected events. Therefore, both processes require detailed planning/scheduling, follow up and governance, with continuous assessment and feedback from key stakeholders. Building upon these similarities, application of the agile method in education (i.e. during the planning of teaching-learning processes) focuses on three key characteristics: agility, extremes and independence.

Constructivist learning theory assumes that there are no two identical students: everyone has different abilities, preliminary knowledge, ranges of interest and learning needs. Not all students are able to learn at the same pace, along identical methodologies. Consequently, the most important task of teachers is to help students in learning and construing their knowledge. All these have to be taken into consideration when planning the teaching-learning process through emphasizing the interaction and communication required among students/teachers and the requirement of adapting to changing needs. These assume agility: the teacher should be able to adapt quickly to students' skills and needs and modify courses. Adaptation and 'finetuning' of courses can happen properly and in a planned way if students get continuous feedback on their work (in the form of formative evaluation) and they also help teachers with informal (and often anonymous) feedback. This is the 'extreme' characteristics of the ATLM. During the application of this method the central role of teachers continuously fades away, they gradually pull out of the teaching-learning process, while students get more and more self-confident to learn independently and gain the skills, which are important from the aspect of lifelong learning. This is the dimension of independence. For all these to get implemented in classroom practice, the following methodological solutions are proposed: knowledge sharing among students, continuous feedback and teaching learning.

3.4 Challenges to Assessments

While summative methods are very important and they have a clear pedagogical foundation with new methods of teaching come new methods of assessment as well [33]. These methods move beyond the traditional approaches and propagate in-process evaluation of students' comprehension and progress. Formative assessments are formal and informal procedures conducted by teachers during the learning process and are aimed for supporting learning. They are supportive and development focused assessment techniques [34] and include for example diagnostic testing, heterogenic assessment, as well as self- and peer assessment. In addition, to treat students in a holistic manner, it is not irrelevant how students feel about themselves and their education. Consequently, student well-being is considered as a fundamental condition of successful teaching [35]. A clear challenge for BIS is how this philosophy and corresponding techniques may be integrated with the nature of the field as discussed in previous subsections.

3.5 Challenges of Teaching BIS Online

The pace of technological development constantly offers new opportunities and the context of learning is increasingly shaped by digital media including the personal ownership of various (e.g. mobile) devices. But teaching BIS online – or mostly online – is not straightforward and has its – already existing – challenges of its own. This is due to the fact, that in a digitalized world, education, like many other sectors, could not avoid adopting new technologies. A lot has changed over the past two decades or so since the birth of the idea of 'online learning'. Even the terminology has integrated a mushrooming set of new expressions: e-Learning, blended learning, distance education, technology enabled teaching, hybrid education, MOOC, virtual classroom, just to name a few. This is even further magnified by the difficulty of teaching computer soft skills (personal communication, groupwork, project management, etc.) online [36].

3.6 Special Challenges of the COVID Pandemic

While eLearning has been around for over two decades now, the recent global challenge invoked by the COVID-19 pandemic has put online education into the forefront of academic attention – both as a technological opportunity to maintain the continuity of teaching (at all levels of education) and as a challenge to innovate and apply new methodological approaches. The current pandemic put extra strain and challenge on most universities to retain the quality of their education. It has become clear that innovative approaches are needed – and needed fast: approaches that can help to deliver high-quality education from a distance. COVID thus has pushed online, blended, hybrid solutions, but those have their own problems in themselves which this rush to respond just further. As a most recent development our social context – shaped by fear and protective distancing – influences expectations and modes of knowledge exchange as well. "*During the pandemic the learning space has become fully digital including the same learning resources. While learning space is transforming, we also need to rethink about the other qualities of the learning design in IT education and proceed with potential adjustments*" [37] (p. 1).

However, while (aforementioned) modern teaching methods assume a well-organized learning space to be successful, this appeared not to be the case under the changes introduced as a reaction to COVID. While there was a (sudden) move to online or blended education, results may be described being only partial solutions in the sense that while teaching is now technically online, it really only utilizes technology to allow access. Indeed, it does not seem to involve full methodological adjustment to take advantage of technology. In other words, reorganizing teaching did not fully happen along clear methodological guidelines (such as flipped classroom practices, for example), instead, it simply moved more materials online. This is true even for videos, which were prepared out of necessity and their creation was not a result of applying consistent methodological principles (i.e. it has happened more reactively as opposed to being carefully planned). Thus, learning spaces were more ad-hoc than designed.

4 Towards an Advanced BIS Curriculum Framework

The world of information systems and info-communication technologies (ICT) in general are changing fast, sometimes rapidly. Therefore, everything we say about systems design or IS education is rather relative and need to be put into historical context to understand why changes happen and what is the expected lifetime of a paradigm-shift in the field. However, the goal of redesigning BIS education is not only the need to keep up with this pace, indeed, as it was demonstrated so far, there are additional factors that influence the way BIS may be taught.

It was already realized by Zachman ([38], see also [39] for an update) that due to the development in data processing, implementation of IT supported business functions often result in rather isolated solutions, and instead of being an accelerator of adaptivity and supporter of competitiveness, costly IT solutions often freeze the enterprise at the technological and application level applied at a given time. Indeed, because IT system are usually large investment and even when old can still work relatively well, their replacement by the latest technology, platforms, or solutions is a difficult decision, not to mention the costs and risks. Instead, a more flexible view is needed, one that is built on architectural concepts. This approach eventually led to the development of The Open Group Architecture Framework or TOGAF [40]. Indeed, this approach provides a guideline around which an evolutionary BIS curriculum design approach may be organized.

TOGAF differentiates among several architecture domains (called the Enterprise Architecture Model – EAM): business architecture, information systems (data and application) architecture and technology architecture. For enterprises this view may be used to create a process of systematic redesign. In each domain there is a baseline and a target architecture, and a gap analysis can create a roadmap of change. This way the organisation and IT management can follow a well-controlled and coherent development scenario. The suggested architecture development method (ADM) is split into four phases: creating the architecture context; architecture delivery; transition planning; and architecture governance. This creates an opportunity for a customizable framework, repeatable architecture development, which means stepping further towards the advanced, integrated solution; considering re-usability, standardization, interoperability, and portability.

From a different point of view the dimensions and the process of TOGAF may be utilized as a backbone for BIS curriculum design since the EAM is built on the strong correlation between IT technology and business management (which is key to BIS). If a curriculum is considered as set of requirements that need to be met during T&L, it is easy to see that these requirements may change by time, place, type of audience, level of education, and the way of implementation. Requirements might reflect professional viewpoints (such as the AIS guideline) or the short-term interest of the labour market or long-term, future demand of the world of labour (that may be hard to predict). Therefore, similarly to the TOGAF philosophy, separation of requirements (or in the EU, competences) from implementation is a must.

This could be augmented with the latest pedagogical approaches to make it fresh, approachable, and ready for blended learning. In every stage of the architecture development method developers have to contrast the information technology solution with business objectives, processes, and maturity. This and the relatively low level of complexity of EAM fits well to the idea of problem-based T&L. Students may be posed an (organizational IS) problem and seeking solution(s) would force them to explore relevant concepts, information, and techniques while incurring required skills and competencies. One may skip traditional course design, since problem-solving is now placed into the centre of learning. Indeed, one may even start with a very complex, almost unsolvable problem, which then would need to be split into smaller issues first.

Once the original problem was broken down into smaller ones, instead of being 'taught', students will study the business, its environmental and societal context, and its characteristics which, hopefully, will lead to even smaller sub-problems that are more feasible to solve. The expected final outcome is an outline of a working model. During this process – instead of studying material from isolated courses and dedicated lectures – students would need to learn business economics (including firm theory, sociology, regulations, and so on) and at every stage they will need to learn the corresponding IT technology part as well. The problem-solving process under this case-based framework will indicate where and when to introduce system design principles, and procedures, database design, business intelligence methods, or governance issues. It may depend on the timeframe of training, but at least two iterations are necessary. Student audience must confront the barriers of the (suggested) solution. This way they will also understand what the roles of maturity models, transitioning, and audit are – thus getting a full picture of an organization and its information systems. The approach would especially be effective in a dual education (internship, work placement) context.

5 Summary and Future Direction

This proposition paper provided a systematic and comprehensive overview of the challenges BIS programs to face and need to address in our post-pandemic educational context. The review of employer and alumni opinion as well as current BIS education best practices was combined with a landscape of up-to-date teaching methods with focus on teaching computer and organizational soft skills. In light of an increasingly student-centred world augmented with extended online options the paper put forward a BIS education design framework based on TOGAF. The argument for the need and potential success of this approach is that it is capable of addressing the existing set of interrelated issues and challenges in an integrated manner. Admittedly, one limitation of this paper is that the six dimensions investigated in Sect. 3 were concluded from literature. The obvious next step is then to put the suggested approach into practice and create a BIS curriculum organized around TOGAF.

References

1. Topi, H., et al.: Curriculum Guidelines for Undergraduate Degree Programs in IS. ACM (2010)
2. Topi, H., et al.: MSIS 2016 global competency model for graduate degree programs in information systems. Commun. AIS **40**, 1–107 (2017). Article18
3. Boehler, J.A., Larson, B., Peachey, T.A., Shehane, R.F.: Evaluation of information systems curricula. J. Inf. Syst. Educ. **31**(3), 232–243 (2020)
4. Nasir, S.A., Yaacob, W.W., Aziz, W.W.: Analysing online vacancy and skills demand using text mining. J. Phys. Conf. Ser. **1496**, 012011 (2020). https://doi.org/10.1088/1742-6596/1496/1/012011
5. Cummings, J., Janicki, T.N.: What skills do students need? a multi-year study of it/is knowledge and skills in demand by employers. J. Inf. Syst. Educ. **31**(3), 208–217 (2020)
6. Lankhorst, M.: Enterprise architecture at work. Springer Berlin Heidelberg, Berlin, Heidelberg (2017)
7. Pitukhin, E.: Job advertisements analysis for curricula management: the competency approach. In: 9th Annual International Conference of Education, Research and Innovation, Seville, pp. 2026–2035 (2016)
8. Dubey, R.S., Tiwari, V.: Operationalisation of soft skill attributes and determining the existing gap in novice ICT professionals. Int. J. Inf. Manage. **50**, 375–386 (2020). https://doi.org/10.1016/j.ijinfomgt.2019.09.006

9. Szabó, I., Neusch, G.: Comparative analysis of highly ranked BIS degree programs. In: Proceedings of the Business Information Systems Conference Workshops, Hannover, Germany, June 14 (2021). (In this Volume). https://doi.org/10.1007/978-3-030-04849-5
10. Apigian, C.H., Gambill, S.: A descriptive study of graduate information systems curriculums. Rev. Bus. Inf. Syst. (RBIS) **18**(2), 47–52 (2014). https://doi.org/10.19030/rbis.v18i2.8978
11. Landry, J.P., Saulnier, B.M., Wagner, T.A., Longenecker, H.E.: Why is the learner-centered paradigm so profoundly important for information systems education? J. Inf. Syst. Educ. **19** (2), 175–180 (2008)
12. Mamina, R.I., Tolstikova, I.I.: Phygital generation in free global communication. Int. J. Open Inf. Technol. **8**(1), 34–41 (2020)
13. Tolstikova, I., Ignatjeva, O., Kondratenko, K., Pletnev, A.: Generation Z and its value transformations: digital reality vs. physical interaction. In: Alexandrov, D.A., Boukhanovsky, A.V., Chugunov, A.V., Kabanov, Y., Koltsova, O., Musabirov, I. (eds.) DTGS 2020. CCIS, vol. 1242, pp. 47–60. Springer, Cham (2020). https://doi.org/10.1007/978-3-030-65218-0_4
14. Cook, V.S.: Rethinking learning engagement with Gen Z Students. e-mentor **80**(3), 67–70 (2019). https://doi.org/10.15219/em80.1425
15. Davidson, C.N.: The new education: how to revolutionize the university to prepare students for a world in flux. Hachette, UK (2017)
16. Geiger, A.W., Davis, L.: A growing number of American teenagers–particularly girls–are facing depression. Pew Res. Center **12** (2019). https://www.pewresearch.org/facttank/2019/07/12/a-growing-number-of-american-teenagers-particularly-girls-are-facingdepression/
17. Gehlen-Baum, V., Weinberger, A.: Notebook or Facebook? how students actually use mobile devices in large lectures. In: Ravenscroft, A., Lindstaedt, S., Kloos, C.D., Hernández-Leo, D. (eds.) EC-TEL 2012. LNCS, vol. 7563, pp. 103–112. Springer, Heidelberg (2012). https://doi.org/10.1007/978-3-642-33263-0_9
18. Davidovitch, N., Yossel-Eisenbach, Y.: The Learning paradox: the digital generation seeks a personal, human voice. J. Edu. E-Learn. Res. **6**(2), 61–68 (2019)
19. Barrows, H.S.: Problem-based, self-directed learning. JAMA **250**(22), 3077–3080 (1983). https://doi.org/10.1001/jama.1983.03340220045031
20. McComas, W.F.: Problem based learning. In: McComas, W.F. (ed.) The Language of Science Education, pp. 76–76. SensePublishers, Rotterdam (2014). https://doi.org/10.1007/978-94-6209-497-0_66
21. De Graaf, E., Kolmos, A.: Characteristics of problem-based learning. Int. J. Eng. Educ. **19** (5), 657–662 (2003)
22. Levy, P., Little, S., Mckinney, P., Nibbs, A., Wood J.: The Sheffield Companion to Inquiry-Based Learning. The Univ. of Sheffield, Brook Hill, UK (2010). http://www.shef.ac.uk/ibl
23. Spronken-Smith, R., Angelo, T., Matthews, H., O'Steen, B., Robertson, J.: How effective is inquiry-based learning in linking teaching and research. In: An Int. Colloquium on Int. Policies and Practices for Academic Enquiry, 7, 4, pp. 19–21. Marwell, Winchester, UK (2007)
24. Lee, V.S.: Teaching and Learning Through Inquiry: A guidebook for Institutions and Instructors. Stylus Pub. LLC (2004)
25. Ernst, D.C., Hodge, A., Yoshinobu, S.: What is inquiry-based learning. Notices AMS **64**(6), 570–574 (2017). https://doi.org/10.1090/noti1536
26. Lage, M.J., Platt, G.J., Treglia, M.: Inverting the classroom: a gateway to creating an inclusive learning environment. J. Econ. Educ. **31**(1), 30–43 (2000)

27. Bishop, J.L., Verleger, M.A.: The flipped classroom: A survey of the research. In: 120th ASEE National Conference and Exposition, Atlanta, GA (paper ID 6219). American Society for Engineering Education, Washington, DC (2013). https://doi.org/10.18260/1-2–22585
28. Lo, C.K., Hew, K.F., Chen, G.: Toward a set of design principles for mathematics flipped classrooms: a synthesis of research in mathematics education. Educ. Res. Rev. **22**, 50–73 (2017). https://doi.org/10.1016/j.edurev.2017.08.002
29. Bergmann, J., Sams, A.: Flip Your Classroom: Reach Every Student in Every Class Every Day. International society for technology in education (2012)
30. Tucker, B.: The flipped classroom. Educ. Next **12**(1), 82–83 (2012)
31. Yarbro, J., Arfstrom, K.M., McKnight, K., McKnight, P.: Extension of a Review of Flipped Learning (2014). https://flippedlearning.org/wp-content/uploads/2016/07/Extension-of-FLipped-Learning-LIt-Review-June-2014.pdf
32. Chun, A.H.W.: The agile teaching/learning methodology and its e-learning platform. In: Liu, W., Shi, Y., Li, Q. (eds.) ICWL 2004. LNCS, vol. 3143, pp. 11–18. Springer, Heidelberg (2004). https://doi.org/10.1007/978-3-540-27859-7_2
33. Yorke, M.: Formative assessment in higher education: moves towards theory and the enhancement of pedagogic practice. High. Educ. **45**, 477–501 (2003). https://doi.org/10.1023/A:1023967026413
34. Pereira, D., Assunção Flores, M., Niklasson, L.: Assessment revisited: a review of research in assessment and evaluation in higher education. Assess. Eval. High. Educ. **41**(7), 1008–1032 (2016). https://doi.org/10.1080/02602938.2015.1055233
35. Jones, E., Priestley, M., Brewster, L., Wilbraham, S.J., Hughes, G., Spanner, L.: Student wellbeing and assessment in higher education: the balancing act. Assess. Eval. High. Educ. **46**(3), 438–450 (2021). https://doi.org/10.1080/02602938.2020.1782344
36. Tabatabaei, M., Gardiner, A.: Recruiters' perceptions of information systems graduates with traditional and online education. J. Inf. Syst. Educ. **23**(2), 133–142 (2012)
37. Pappas, I.O., Giannakos, M.N.: Rethinking learning design in IT education during a pandemic. Front. Educ (2021). https://doi.org/10.3389/feduc.2021.652856
38. Zachman, J.A.: Framework for information systems architecture. IBM Syst. J. **26**(3), 276–292 (1987). https://doi.org/10.1147/sj.263.0276
39. Sowa, J.F., Zachman, J.A.: Extending and formalizing the framework for information systems architecture. IBM Syst. J. **31**(3), 590–616 (2010). https://doi.org/10.1147/sj.313.0590
40. OpenGroup: The TOGAF® Standard, Version 9.2. (2018). https://publications.opengroup.org/c182?_ga=2.224960986.1921117380.1619948278-1553644343.1619948278