Informing Science: the International Journal of an Emerging Transdiscipline

An Official Publication of the Informing Science Institute InformingScience.org

Inform.nu

Volume 22, 2019

Challenges in Designing Curriculum for Trans-disciplinary Education: On Cases of Designing Concentration on Informing Science and Master Program on Data Science

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Abstract

Aim/Purpose	The growing complexity of the business environment and business processes as well as the Big Data phenomenon has an impact on every area of human activity nowadays. This new reality challenges the effectiveness of traditional narrowly oriented professional education. New areas of competences emerged as a synergy of multiple knowledge areas – transdisciplines. Informing Science and Data Science are just the first two such new areas we may identify as transdisciplines. Universities are facing the challenge to educate students for those new realities.
Background	The purpose of the paper is to share the authors' experience in designing curriculum for training bachelor students in Informing Science as a concentration within an Information Brokerage major, and a master program on Data Science.
Methodology	Designing curriculum for transdisciplines requires diverse expertise obtained by both academia and industries and passed through several stages - identifying objectives, conceptualizing curriculum models, identifying content, and development pedagogical priorities.

Accepting Editor Eli Cohen │Received: December 8, 2018│ Revised: January 14, April 8, 2019 │ Accepted: April 9, 2019.

Cite as: Christozov, D., Rasheva-Yordanova, K., & Toleva-Stoimenova, S.. (2019). Challenges in designing curriculum for trans-disciplinary education: On cases of designing concentration on informing science and master program on data science. *Informing Science: the International Journal of an Emerging Transdiscipline, 22,* 19-30. https://doi.org/10.28945/4300

Contribution	Sharing our experience acquired in designing transdiscipline programs will contribute to a transition from a narrow professional education towards addressing 21st-century challenges.
Findings	Analytical skills, combined with training in all categories of so-called "soft skills", are essential in preparing students for a successful career in a transdiciplinary area of activities.
Recommendations for Practitioners	Establishing a working environment encouraging not only sharing but close cooperation is essential nowadays.
Recommendation for Researchers	There are two aspects of training professionals capable of succeeding in a transdisciplinary environment: encouraging mutual respect and developing out-of-box thinking.
Impact on Society	The transition of higher education in a way to meet current challenges.
Future Research	The next steps in this research are to collect feedback regarding the professional careers of students graduating in these two programs and to adjust the curriculum accordingly.

Keywords	informing science, data science, transdiscipline, education

INTRODUCTION

There are several terms used to identify the stage reached by human society – information society, knowledge society, etc. But behind all those qualifiers lays the advancement of computer and communication technologies, known as information technologies (IT), and the effect this advancement causes to all facets of human life nowadays. Modern IT allows registering and storing of all facts related to occurring events in searchable repositories. This naturally leads to an accumulation of a huge volume of heterogenic data, known as "Big Data", as well as a growing dependence on how these data are used and how people acquire actionable knowledge – becoming informed.

With its development, society reached the point where humans are unable to comprehend available data without the heavy use of IT. The last couple of decades are characterised by emerging new scientific areas by combining fields such as IT, mathematics, statistics, algorithms, machine learning, artificial intelligence, and so forth, with other specific domains. Terms like "interdisciplinary" or "multidisciplinary" do not fully explain the specifics of such cooperation. These terms define cooperation preserving relative independence among the fields. The new realities require integration of specific knowledge for different fields on a much higher level – the term "transdiscipline" explains this fusion of expertise better (Lotrecchiano & Misra, 2018) and creates synergy.

The two disciplines – Informing Science and Data Science – represent good examples of transdisciplines. The evolution of Information Systems as a field of research and practice reached the completion point of its initial scope around the 1990s. Many authors (see, for example, Buckland, 1991) identified the need for a new understanding of the role that IT plays in society, but also in everyone's life. In 1999, the concept of Informing Science emerged (Cohen, 1999) as a transdiscipline to address the variety and diversity of aspects one has to consider to inform clients – from pure technical aspects of informing via the use of IT, to exploring achievements in cognitive science of how a human acquires information and develops actionable knowledge.

In the last decade, we are witnessing an unprecedented explosion of organizations' attention toward data and how to benefit from data. This understanding of the value of data, together with the availability of technologies that allow the processing of huge amounts of data objects in a meaningful time, resulted in the appearance of a new scientific field - Data Science. Today, this topic is one of the most discussed in research and practices as many organizations are striving to use the data they possess or control it in a way to improve effectiveness and efficiency of their operations (Kowalczyk

& Buxmann, 2014) and to gain competitive advantages. Data Science is another example of a trans-discipline, also built by a synergetic contribution of diverse areas of knowledge – from pure technological achievements to process Big Data via intensive use of data analytical techniques toward different, forms, defined by the data domain, to present and visualize results in a compact and informative way.

"Classical" areas of Information Systems address mostly efficiency of storing retrieved data, but they do not support extracting useful patterns and relations – learning – in the needed level of convenience. In order to gain knowledge from the accumulated complex and complicated data, a special class of computer applications are developing. This, in turn, limits the number of people who possess the necessary expertise to take advantage of the available data resources (Christozov & Rasheva-Yordanova, 2017; Christozov & Toleva-Stoimenova, 2015; Christozov, Toleva-Stoimenova, Rasheva-Yordanova, & Vukarski, 2016). Thus, the Big Data phenomenon imposes a new social divide between those capable of benefiting from Big Data (members of the so-called "Big Data Elite") and those relying on intermediaries in order to "study" from data. This new divide adds new aspects to the already existing digital divide in society (Christozov & Toleva-Stoimenova, 2015). To benefit in full with exploring Big Data requires combining and applying multidisciplinary expertise and diverse competences. Both fields – Informing Science and Data Science – address these emerging challenges.

These new realities are challenging, not only for business but also for education, especially for university level education. Departing from well-established, matured ways of training students in a narrow field and moving towards developing flexible and adaptable expertise is really challenging for such a conservative industry with a long "manufacturing process" such as education, especially when the needs for competences are changing so rapidly. Training students in transdisciplines represents an excellent example of how difficult it is to design curriculum and educate students for the challenges of business nowadays and for the observable future.

The two transdisciplines – Informing Science and Data Science – are in the scope of the Bulgarian University of Library Studies and Information Technologies (ULSIT). An information brokerage major was launched in 2002 (Christozov, Denchev, Toleva-Stoimenova, & Rasheva-Yordanova, 2008; Christozov & Nikolova, 2001) and its evolution follows developing Informing Science as a scientific field. Designing an Informing Science concentration within the Information Brokerage major and a Master program in Data Science, emphasizing the transdisciplinary nature of the two fields, faces several challenges, including what are the leading objectives in designing curriculum, how to define the content a discipline has to cover and the competences to train, what is an acceptable way of splitting the content in separate courses and scheduling offerings, how to identify and attract competent instructors. Last, but not least, the programs have to pass accreditation and justify compliance with standard requirements, made to assess the quality of education in its "classical" form.

The paper shares experience in designing a curriculum to educate professionals capable of serving society by exploring Big Data and informing clients. A discussion regarding the leading principles in designing a curriculum for training in a transdiscipline field is presented in the next section – Guidelines. In the next two sections, an outline of the two curricula is described. The importance of emphasizing the transdiscipline character of the two programs is commented on the section that follows, where the two curriculum models are compared and assessed from the point of view of the expected audience. The discussion raises several still open questions. In conclusion, we try to assess what was achieved, but also we share our plans for future empirical research on how well the competences acquired by students help them and their employers to benefit in the challenging market conditions nowadays.

GUIDELINES

Designing a curriculum is a process based on a preliminary set of objectives, limited by given circumstances, assumptions, and constraints. The curriculum design framework is established by acquiring, via formal or informal ways, numerous pieces of information, which forms an understanding regarding the competences valued by industry and the expected background of students. Formally, the design of a curriculum is to design a process of a given input (entry background) and output (job market demand). This section tries to summarize this understanding, which shapes the rest of the paper.

LEADING PRINCIPLES

The recent demand for specialists in the area of exploring data and information in the job market justifies the need for training professionals capable of serving as data scientists – mediators between Big Data and decision makers, or as information brokers – mediators between information resources and end-users. The set of competences expected from these two areas of expertise are highly overlapped, but there are still some differences. Nowadays, a Data Scientist is a professional with primarily IT competences, but in the set of Information Brokers' competences, the soft skills – face-to-face communication – dominates.

Knowledge areas, as identified by the authors as important for both disciplines, include technical, cognitive, and managerial or domain knowledge, as well as data-related issues such as data quality, data organization and structuring, and data analytics addressing a given domain perspective. More specific for the Information Brokerage field are skills to assess information credibility, to trace information to their origin, and to map findings to specific ways the client may accept and trust them. In the area of Data Science, deeper competences in data analysis techniques, especially statistical methods, rational selection and conscious application of data analytic applications, and ergonomic aspects of visualization, were identified as specific knowledge areas.

Understanding the transdiscipline nature of the competences needed by such professionals was the leading principle in discussions and justifications while constructing the two curricula.

The following features of the transdiscipline nature of these programs were identified:

- holistic view of problems: viewing problems and factors with an impact on their interrelation and interdependence;
- broader perspective in solving problems; and
- multidimensional nature of reality.

Emphasis was given to training competences and developing skills rather than transferring knowledge in the form of memorizing facts, problem-solving attitude and agility, building capability for lifelong learning and self-actualization, flexibility and adaptability.

The following questions in designing a curriculum for training students in transdisciplines were addressed:

- how to balance the content in a way to train the needed competences; and
- how to schedule offerings of courses in a way that allows smooth progress in acquiring the necessary competences.

In the next two subsections, we try to address these issues.

HOW TO BALANCE THE CURRICULUM OF A TRANSDISCIPLINE?

Designing a curriculum is always an optimization trade-off between what is assumed the program has to cover with what is possible to cover within the program timeframe, students' background and cognitive limitations of accepting new ideas and mastering new skills. The educational form provides these constraints, in particular:

- A concentration within a given major is limited to include a set of three to five courses, where at least two are required by the major and the rest have to be selected among electives.

- A three to four semester master program is limited to two semesters with four courses each, while the third semester is dedicated to developing a master thesis. An extra, preliminary, semester is organized for students lacking the expected background.

The natural approach in rationalizing curriculum is to reduce redundancy, emphasizing the opportunity to cover larger and richer content. The opposite, overlapping content, allows presenting the same concepts from different perspectives, emphasizing broader and diverse views of problems, and reaching and assessing different “correct” solutions.

Traditional education usually tries reducing the redundancy, which allows the required topics to be covered in more detail and to master the specific skills needed by the narrow field. Training transdiscipline competency needs just the opposite – presenting different aspects from multiple perspectives, exploring alternative techniques in searching, critically assessing, and rationality in choosing “good enough” solutions.

How to Schedule Offerings of a Transdiscipline?

Scheduling is another issue needing careful consideration. Training looks like a jigsaw puzzle. The two programs offer different challenges in this aspect of curriculum design.

The Informing Science concentration is built within an Information Brokerage major, which introduces two categories of competences – designing computer-based Information Systems for a business entity and serving as a consultant – information mediator. The concentration requires that students take five specific elective courses spread around the eight semesters of study, with students of relatively homogenous backgrounds.

In designing a Data Science Master Program, one faces much more complicated challenges. The cohort follows the same preliminary defined sequence of courses, despite the diverse background, especially for competences in fundamental areas such as mathematics, probability theory, information theory, and software development. Students who completely lack such background have to pass preliminary training, but in general, the expertise in these fields varies significantly. From the other side, students in a master program already possess some working experience, which makes it much easier to show them the benefit of discussed problems. Also, the diverse experience of the audience is beneficial in training a transdiscipline. Diverse points of views are presented naturally, and discussions regarding the rationality of a given solution are fruitful and beneficial to all.

The Two Programs’ Curricula

The Informing Science concentration within the Information Brokerage major and the Data Science Master Program are described into the next two subsections.

Information Brokerage and Informing Science Concentration

The major of Information Brokerage was launched in 2002 (Christozov et al., 2008). During this period, it was updated several times to address changes in the area. The last outline of the curriculum was defined in 2017. The list of courses is presented in Appendix A. Information Brokerage students are specifically advised to take more modern languages courses; for example, English at second and third level and another foreign language of their choice from French, German, Spanish and Russian. The program was originally developed (Christozov & Nikolova, 2001) based on an author’s industrial experience, emphasizing the need for mediators between the growing volume of available information and clients of that information.

The professional paths of alumni show two major directions in their careers. The first group is working in large or middle-sized companies and is engaged in developing information services to different categories of employees. Usually, this is done in a type of Information Service department. The primary purpose is to serve the analysis of information needs and to help designers in building useful tools. Competences in the area of computer technologies were identified as most important. The second group joined consulting entities providing information services to a variety of clients. The emphasis lies on communication skills as well as on competences to identify, locate, and retrieve data, and also to assess data validity and credibility, and to present it in the best possible way for the given clients. This feedback was used in updating the curriculum of the Information Brokerage program by introducing two concentrations.

The first emphasizes the design of information systems and also requires students to pass the following five elective courses:

- SQL Programming
- ERP Systems
- Methodologies for Software Engineering
- Advanced IS Design
- Data Mining.

The second concentration prepares students to serve a larger community with a diverse clientele. The concentration is designed by following leading principles developed within the scope of Informing Science. The five elective courses in this concentration are:

- Theory and Practice of Consulting
- Informing Processes and Systems
- Big Data Analytics
- Knowledge Organization and Management
- Information Society and Policies.

In both concentrations, students are trained to pay special attention to clients, the way they are acquiring information and how the obtained data is transformed into actionable knowledge, and to use different techniques to improve this process. The first category of students are trained to be more engaged in designing computer applications and other technological aspects of information supply, and the second to develop human-to-human communication skills. Figure 1 illustrates the target distribution of competences in this program.

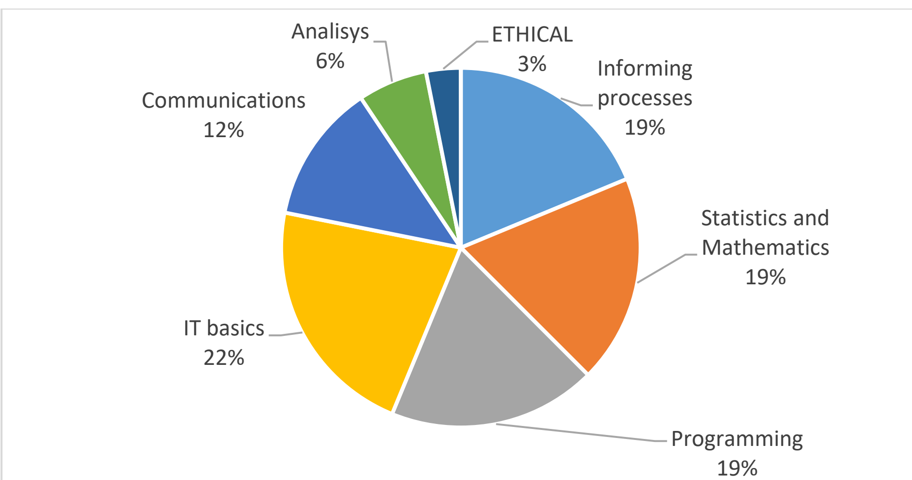

Figure 1. Distribution of competences in the Information Brokerage program

MASTER OF DATA SCIENCE

The program was designed and launched in 2018. It is open for students with diverse backgrounds. This allows for different views on a problem and leads to interesting class discussions and developing a "transdiscipline" attitude. At the same time, to justify the opening of the program, bachelors in the

Information Brokerage major were identified as the natural target group, assuming their background as the starting point. Students coming from different disciplines have to prove expertise to join the program directly or take a preliminary semester to obtain the needed entry competences.

The program's objectives are defined by addressing mutually accepted competences (see, for example, Granville, 2016) and what were shared by representatives of the industry. Competences in performing data analysis (analytical skills) were recognized as the common ground for transforming a group of heterogeneously trained individuals into a transdiscipline innovation team (Lotrecchiano & Misra, 2018; Rasheva et al., 2018). These two aspects define the circumstances in designing the Data Science Master Program curriculum – an emphasis on building analytical competences in a heterogeneous audience.

The program is designed on two levels of abstraction. The first level – list of courses in the Data Science Curriculum as approved and accredited – is presented on Appendix B. The second level covers pedagogical practices applied in class. To avoid misunderstandings, all students are expected to possess a minimal mathematical and statistical background. Students missing such competence have to pass one semester preparation in these areas.

Transdiscipline Nature of the Two Programs

Training students for a successful career in transdisciplines is achieved in two ways. First, by offering diverse content, techniques, and views on the same problems, with a clear message that a successful solution needs combing and synergizing multiple knowledge areas. Students have to realize that in the modern world there is no one single "true" way for finding the solution to complex problems. The key competence needed is to identify and classify a problem to the transdiscipline category, which does not have a simple solution. A multidimensional view on such problems, and understanding the need for a holistic way in solving them, taking into account different and diverse aspects and views, requires a broader vision and flexibility as well as a problem-solving attitude. Agility is another dimension in solving problems nowadays.

The second key aspect of training those students is developing skills to work in heterogeneous teams. In general, those skills are marked as "communication skills". The majority of institutions stress the active side of communication, literally efficient writing and presenting, undermining its passive aspects – listening and hearing. Working in a transdiscipline team, the passive role (Christozov & Toleva-Stoimenova, 2015) of communication is essential. The ability to hear and understand the ideas expressed by different members of the team, with different backgrounds, using different jargon, different logic, and emphasizing different reasons, is becoming the key success factor.

The two programs emphasize these two aspects in different ways, but targeting similar results. The Informing Science concentration stresses effective informing, which requires the ability to understand diverse clients' views on problems and their ways of accepting information. From one side, this requires expertise to understand broader ways of presenting problems specific to different domains. From the other side, this requires exploring multiple ways to address problems and to present potential solutions to the clients in an appropriate and relevant way.

In the Data Science program, the stress is on building analytical skills in data processing. The ability to extract knowledge from data collected within different domains develops the required broader and diverse expertise, which also contributes to building the necessary communication skills. The Big Data phenomenon is associated with indirect observation of data, or data are seen only as summarized statistics produced by IT applications. This forces all members of such transdiscipline teams to possess sufficient competences in the areas of Statistics and Machine Learning applications, which itself represents the common ground for communication.

MAJOR CHARACTERISTICS OF TRAINING TRANSDISCIPLINES

While reviewing the experience obtained in designing the two programs, we had identified several aspects that define the extent to which one program prepares students for the transdiscipline nature of solving problems nowadays.

The major one is migration from transferring knowledge towards developing skills and competences. With the rise of availability of information resources and easiness to acquire information via the Internet, the need for memorizing facts, formulas and techniques is becoming less and less important. Memorizing is switching with abilities to find relevant information, understand it, map it to the problem, and apply information in an appropriate way. This is recognized globally and education gradually is moving toward training those competences rather than forcing students to "know by heart" facts.

The second one is to develop respect toward others' opinions. We call it "ethics". Overcoming the natural arrogance of a narrowly trained expert towards the "illiterate" others is one of the major obstacles for the success of transdiscipline teams.

The third aspect is the ability to understand correctly the arguments presented in the professional jargon used in other disciplines. Broader education, usually implemented as a "general education" component in liberal-arts institutions, allows achieving such competences. Misinforming is among the major risks for the success of such teams, but it may serve to reach an innovative, out-of-box, solution (Lotrecchiano, 2017, personal communication).

DISCUSSION

TWO TYPES OF EDUCATION MODEL

There are several educational models with different challenges in designing transdiscipline training. To illustrate this we can compare in brief the "classical" European model of education with an emphasis on a narrow, deep professional training, with the "liberal arts" model developed and widely used among universities in the United States. The general education component plays a significant role within the liberal-arts education.

The major characteristics of the liberal arts model can be summarized in the following three principles:

- *Broader education.* All students are introduced to a variety of disciplines from mathematics to fine arts, as a general education component, which covers more than one-third of their study.
- *Freedom of choice.* Students have to develop their own road map for acquiring knowledge and meeting requirements, and they also have the freedom to change their initial ideas.
- *Community life.* Building citizenship responsibilities within the immediate and larger community, which emphasizes humanistic and social subjects.

The two programs described above are implemented within the framework of an institution closely following the traditional European model. In our view, the liberal-arts education provides a better environment for training transdisciplines. The general education component allows students to obtain a diverse background and to develop skills in understanding ideas presented in different fields and by using different professional jargons. Community life places students in interaction with peers studying different subjects and facing a variety of problems from different domains. The natural desire to help friends promotes the sharing of ideas and horizontal knowledge transfer. And last but not least, the freedom of choice develops a problem-solving attitude and an opportunity to study subjects from other areas, different from what is required for a main-stream course for a given profession.

The traditional European Education model emphasizes knowledge transfer and stresses professional training by meticulously addressing problems and solutions. Students develop deep knowledge in a relatively narrow area. To achieve the needed flexibility for success in transdiscipline, all the above components, provided naturally by a liberal-arts model and training environment, have to be included into the curriculum and trained as part of the regular class work. This represents a significant challenge in curriculum design and also in developing appropriate everyday pedagogy.

Comparing the Two Programs from the Point of View of the Educational Level

Our major finding is that success in training transdisciplines is to switch the objectives of training from "knowledge transfer" toward "developing skills and competences". In principle, undergraduate training is dedicated mostly to acquiring fundamental knowledge, theories and concepts, and developing skills for solving problems by directly applying this knowledge. And graduate education, especially at the master level, trains developing skills and competences to solve complex problems in applying different techniques and trying different approaches in a more sophisticated way. Looking at developing the curriculum of the two programs from the perspective of the level of training, the objectives stated for the Data Science master program looks natural. The objectives of the Informing Science concentration, designed for undergraduate education, aims to both transfer knowledge in the developing field, but also developing competences to apply this knowledge. Bearing in mind that, nowadays, especially in IT-related fields, the bachelor level often serves as the terminal degree and the majority of students do not continue their study on to master level, the component of developing skills to "inform clients" becomes a necessity in the profile of an information broker. The lack of maturity in understanding how industries work is one of the major challenges in designing and implementing this program.

Conclusion

This paper shared experiences in addressing the current challenges faced by educational institutions. In a nutshell, those challenges are associated with the inevitability of migration from a narrow and rigid professional training based on knowledge transfer, towards training competences allowing flexibility in adapting to emerging vulnerable circumstances, life-long learning, and agility. Designing the two programs by applying the ideas of transdisciplinarity, aims to achieve these objectives. The major problem was to find the right balance between mastering competences in a given field and developing skills of acquiring the needed knowledge and developing abilities to apply them when needed in cooperation within a diverse team.

Justifying such a curriculum faced significant obstacles including justification and accreditation. The Information Brokerage program faced similar obstacles but proved its vitality over the past fifteen years. Introducing an Informing Science concentration is the next move towards competence-based education and was considered as a small evolutionary step in updating the program. The Data Science program has to prove its design by the performance of students who will graduate.

Both programs need to penetrate into the educational market by breaking the bias of potential students as well as the bias of the industry. The inertia of expectations of what higher education has to do is the major stumbling stone in introducing new nonstandard programs.

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ACKNOWLEDGMENT

This work has been partially supported by National Science Fund at the Ministry of Education and Science, Republic of Bulgaria, within the Project DM 12/4 - 20/12/2017.

APPENDICES

APPENDIX A. INFORMATION BROKERAGE CURRICULUM

Course	Statues	Comments
Introduction to Information Brokerage	Required	Introduction to profession
Introduction to Programming	Required	Introduction to C++ language
Calculus	Required	Mathematical foundation Discrete mathematics
Algebra	Required	
Fundamentals of Informatics	Required	
Probability and Statistics	Required	
Information Science Fundamentals	Required	Library organization, cataloging systems, retrieval
Data / Documents Processing	Required	
Documental Sources	Required	
Information Systems Analysis and Design	Required	
Database Systems	Required	
Introduction to IB Low and Legal regulation	Required	
English 1	Required	
Information Society and Policies	Elective	Introduces students to established information environments, trends, and regulations.

Course	Statues	Comments
Knowledge Organization and Management	Elective	Covers theories of transition between tacit and explicit knowledge.
Informing Processes and Systems	Elective	Emphasizes informing processes, risks, role of culture, and good practices to raise credibility.
Theory and Practice of Consulting	Elective	Covers the structure of consulting process, emphasizing the importance of communication by using formal and informal IS.
Methodologies for Software Engineering	Elective	Waterfall Vs. Agile
SQL programming	Elective	
Advanced IS design	Elective	ERP and CRM systems
Data Mining	Elective	Algorithms
Big Data Analytics	Elective	Address Big Data structuring in a way to support informing. Special attention is given to visualization.
Mobile Technologies	Elective	
Cloud Computing	Elective	
Computer Ergonomics	Elective	Design of intuitive user interface.

APPENDIX B. DATA SCIENCE CURRICULUM

Course	Comments
Preliminary requirements	
Calculus I Probability Theory and/or Mathematical Statistics Discrete Mathematics Software Development (any language) Fundamental Data Structures and Algorithms Relational databases and SQL	Preparation to enter the program for students lacking mathematical, statistical, and IT competences.
First semester	
Introduction to Data Science	Set-up the picture
Statistics: parametric and non-parametric methods for statistical inference	Understanding and interpreting results obtained by applying statistical packages.
Cloud Computing, including Data Centers, NOSQL DB, Hadoop with Map-reduce	IT to support Big Data
Data Analytics • Data warehousing: ETL, data cubes • Data mining: basic problems and algorithms • Text mining: sentiment analysis	IT to support Big Data Analytics
• Visualization.	Techniques to improve users' acceptance.
Second semester	
Big Data Analysis: challenges and benefits; Gartner's EIM Maturity model	Emphasis on human readiness to benefit from opportunities provided by Data Science
Big Data Applications: Architectures	Understanding how an application is designed
Data Driven Management	Benefits, limitations, constraints in exploring data for a purpose

Course	Comments
Applications: • Fraud detection • Exploring social networks - behavioral economics - marketing • "In-house" data management - ERP, BI • Data Science in public services - e-Government • In-memory solutions.	Good practices.
Third semester: Developing master thesis	

BIOGRAPHIES

Dimitar Christozov is a Professor of Computer Science at the American University in Bulgaria, since 1993. He has more than 35 years of research and education experience in areas such as computer science, applied statistics, and information systems. His recent interests are in the fields of business analytics and data science. He graduated in Mathematics from Sofia University "St. Kliment Ohridski" in 1979. He completed his PhD thesis "Computer Aided Evaluation of Machine Reliability" in 1986 and DSc thesis "Quantitative measures of the quality of informing" in 2009.

Professor Christozov has more than 100 publications as separate volumes, journal papers and papers in refereed proceedings. He is a founding member and fellow of the Informing Science Institute, chair of the Bulgarian Informing Science Society, and founding member of the Bulgarian Statistical Society. Currently, Professor Christozov was elected a member of the Executive Board of Bulgarian National Science Fund.

Katia Rasheva-Yordanova is an Assistant Professor of Computer Science at the University of Library Studies and Information Technologies since 2007. She has an MSc degree in Information Technologies and a second MSc in Business and Administrative Communications from the ULSIT, Sofia. She completed her PhD thesis "Overcoming the digital divide via Bulgarian Chitalishte" in 2014. Katia Rasheva has about 20 publications in refereed proceedings. Her research interests are in the fields of Computer Science, Digital Divide, and Data Science. She is a member of the Bulgarian Informing Science Society.

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