4 Fit Future

Far-Future Strategy Development

for STEM Higher Education Teachers

PR1 FIT4FUTURE:

Curriculum and Competence Framework

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1. Management Summary

The FIT4FUTURE Project Result 1 research aimed at the curriculum development by gathering and registering data to confirm the preliminary research and needs analysis conducted at proposal stage and to assess more in-depth the needs of students studying STEM for a curriculum on long-term future forecasting and the training needs of Higher Education (HE) teachers for teaching such a curriculum. It aimed to investigate methods for predicting future development and the context in which they are being used. Research identified existing curricula and offerings of Higher Education Institutions (HEIs) and considered relevant continuous training offers as well as case studies in the industry. Quantitative data in the form of a survey and qualitative data from interviews was collected to determine the needs of STEM HE students and teachers. In order to define the competence matrix and curriculum, all collected data was analysed to understand HE teachers' and students' expectations in more depth.

The desk research investigated mainly European countries to determine what methods are being used within industries and training programs. Findings show that scenarios are being used but that there are not that many cases where long-term future scenarios (LTFS) are being used within industries.

The survey respondents were HE teachers from Germany, Denmark, Portugal and Turkey, the partner countries of the FIT4FUTURE project. Results show that only 11.30% of respondents have been using methods that enable them to look more than 10 years into the future; however, 80% of respondents indicated that they consider long-term future developments relevant to their teaching. While many respondents are not too familiar with foresight methodologies, they indicated wanting to learn more about long-term future scenarios for their teachings. Apart from some teaching domains requiring a shorter time frame, most respondents indicated wanting to look at a time horizon of more than 10 years in their teachings.

Interview findings show that the majority of interviewees are not familiar with the methods used for predicting future developments, mainly due to a lack of pedagogical knowledge of the methods. Since the abstract nature of methods and students' lack of imagination can limit a fully and immersive experience of future scenarios, teachers need to ensure that given scenarios are comprehensible and explainable enough to provide a realistic interpretation.

The findings from the desk research, survey, and interviews confirm the preliminary research and needs analysis conducted at proposal stage and assess more profoundly the needs of STEM students for having a curriculum on long-term future forecasting and the training needs of HE teachers teaching such a curriculum.

The FIT4FUTURE curriculum is meant to fill the gaps and needs identified in the literature review and research analysis. It consists of four modules:

1) Introduction on LTFS basics and theory
2) Overview on LTFS methods
3) Real-life experiences from teaching and industry
4) Additional resources on localised data on future developments

2. Overview Project Result 1

2.1 Introduction

Businesses nowadays are under constant pressure to innovate to remain competitive in the market. The high-tech sector is especially vulnerable to long-term technological, societal, and cultural changes. Therefore, reliance on trend analysis alone is no longer sufficient in understanding future developments in the industry. Far-future strategic decisions need to be built on a sound long-term technology future scenario (LTFS) development methodology that considers not only trend forecasts but also tacit visionary knowledge. Developing multiple LTFSs to project 10 to 20 years into the future supports businesses in anticipating and making sense of potential shifts in their industry as a result of emergent technologies, wildcards, sociocultural change, and in validating business innovation ideas. Higher Education (HE) teachers in STEM-related fields would greatly benefit from a curriculum which provides a valid framework and a reliable methodology to develop methods and approaches in long-term strategy making. Equipping HE teachers with the necessary knowledge and competence needed to introduce LTFS into their regular teaching portfolios and activities would allow them to teach their students the importance of LTFSs and educate them in developing these types of scenarios.

FIT4FUTURE is an Erasmus+ project that is being developed by an international and interdisciplinary project team from Universidade da Beira Interior (UBI) in Portugal, Ege Üniversitesi (EGE) in Turkey, Hochschule der Medien (HDM) in Germany, Syddansk Universitet (SDU) in Denmark and EOLAS in Spain. The project aims at an innovative curriculum at European HEIs in STEM by adding the lacking long-term perspective to strategic management teaching and fostering future employability of students with developed skills in high tech companies.

This first project result (PR1) “Curriculum and Competence Framework'' has aimed at the curriculum development by gathering and registering data to confirm the preliminary research and needs analysis conducted at proposal stage and to assess more in-depth the needs of students studying STEM for a curriculum on long-term future forecasting and the training needs of HE teachers for teaching such a curriculum. This has been done by desk research (task 1) and through the use of quantitative and qualitative data in the form of an online survey and expert interviews (task 2). The goal was to determine the current state of knowledge of HE teachers, to identify the gaps the FIT4Future curriculum has to fill and to derive the curriculum and competence framework (task 3).

2.2. Curriculum and Competence Framework

PR1 focuses on STEM teaching in relation to LTFS in HE institutions. STEM studies are part of a science curriculum and can be defined as subjects and careers in science, technology, engineering, and mathematics (STEM) (Tytler, 2014). To futurize STEM education in HE institutions, the FIT4FUTURE project aims to create a comprehensive far-future strategy development for HE STEM teachers. In an effort to prepare for forthcoming uncertainties, education plays a significant role in preparing learners for their future (Branchetti et al., 2018). The FIT4FUTURE Curriculum and Competence Framework is based on an initial literature review on a national and international level and the result

of discussions with HE experts to gain more insight into experiences with existing methods and anticipated long-term future strategic scenarios.

2.3. Methodology

A comprehensive literature review was conducted to gather existing data on far-future strategy curricula and to allow for a comparison of those with experiences and expectations of HE STEM teachers. A survey questionnaire and interview guide were designed by the project team with the aim to evaluate the current state of knowledge of HE STEM teachers on analyzing and predicting future developments in the context of their instruction and to assist with the needs assessment. The survey was disseminated at each of the HE institutions of the project team, and interview participants were selected by purposive sampling of participants in the survey. The online survey had 125 participants. Interviews (22 in total) were conducted in Denmark, Germany, Portugal, and Turkey to capture the views and experiences of HE teachers and to obtain qualitative data to contextualize the results of the survey. The interviews followed a common methodology clearly describing the purpose and was planned as follows:

1. Participants submitted their contact information in the survey
2. Interview sessions were planned for approx. 30 minutes
3. Each of the interviews consisted of a predetermined set of questions

3. Desk Research Results

An extensive literature review allowed for determining existing pertinent experiences in forecasting and specifically in LTFS applied in STEM teaching in HE institutions. For the purpose of this work package, it is imperative to determine the significance of long-term forecasting for educational institutions, business ecosystems, and the high-tech industry, as well as the approach and skills needed for those promoting, designing and implementing LTFS in HE. This research was done to investigate existing curricula, literature on LTFS, current LTFS methods and methods used in the industry by looking into existing publications in English.

Forecasting uses historical data to make informed estimates to predict the direction of future trends (Tuovila, 2022). Forecasting can support people and organizations in planning for the future. Long-term future forecasting differs from short and medium forecasting. Short-term forecasting can be defined as consisting of the immediate future, usually up to one year, medium-term forecasting as looking beyond a year and as far as three years, and long-term forecasting as any predictions beyond three years (Hague, 2022). The definition of long-term forecasting does vary though and is sometimes defined as a period of a minimum of five years (Frontiers in Digital Health, 2022). While most short-term forecasting uses statistical methods with little qualitative information, long-term forecasting quite often takes advantage of qualitative methods as they provide more accurate predictions given a limited scope (Chambers, J., Mullick, S., and Smith, D., 1971).

This desk research identified and analyzed relevant studies for the purpose of this project. These were taken into consideration for the design of the survey and interview questions. Our research looked at relevant methods in future forecasting, existing curricula in STEM education, and current literature and case studies related to long-term future scenarios and trend forecasting.

3.1. Literature review

An extensive literature review of over sixty resources in the form of research papers, books and reports on long-term future forecasting was conducted and a large number of case studies on existing STEM education and future forecasting were identified and reviewed. Table 1 shows an excerpt from the literature on long-term future forecasting.

Table 1: Literature on long-term future forecasting

Title of the journal or book & title of the paper or chapter	**Country**	**Type of resource**	**Short definition of why this literature resource is relevant for FIT4FUTURE**
She Ji: The Journal of Design, Economics, and Innovation & An Introduction to the Morphological Delphi Method for Design: A Tool for Future-Oriented Design Research	Germany	Research paper	Highlights benefits of (morphological) Delphi method
Principles of Forecasting: A Handbook for Researchers and Practitioners & Expert Opinions in Forecasting: The Role of the Delphi Technique	USA	Book Chapter	Highlights the importance of Delphi groups; that in order to get the best forecast from experts, you can use a structured group technique for eliciting and combining expert judgements
Technological Forecasting and Social Change & Biases in future-oriented Delphi studies: A cognitive perspective	Switzerland & India	Research paper	Focuses on how cognitive biases emerge and how their unfavorable impact can be mitigated in Delphi studies
Futures & From space to time: Factor three: science and fiction		Research Paper	Highlights films as main agent to spread ideas about what's to come in the future and gives examples about certain movies
Futures & The future imagined: Exploring fiction as a means of reflecting on today's Grand Societal Challenges and tomorrow's options	China & Portugal	Research Paper	We can see how the authors analyzed various films and how they found common themes
Technological Forecasting and Social Change & The 'Narrative Turn' in developing foresight: Assessing how cultural products can assist organisations in detecting trends	Denmark	Research Paper	Looks at the definition of trends and the role of cultural products in the construction of reality
Futures & The origins and evolution of scenario techniques in long range business planning	UK	Research Paper	Highlights historical origins and evolution of the three scenario methods
Long Range Planning & Corporate Environmental Analysis in Large U.S. Corporations	UK/USA	Research Paper	Researches the usefulness, problems of implementation, the payoffs of "environmental analysis"

Main approaches and methods used within future scenario development were identified and divided into quantitative scenario development methods and qualitative scenario development and analysis. Cross Impact Analysis, Trend Extrapolation/Trend Impact Analysis, and Fuzzy Cognitive Map are considered relevant methods for quantitative scenario development while the Matrix and Storylines Approach, Delphi Study, Science Fiction Prototyping, Analysis of Science Fiction Novels and Films, Flash Fiction Stories, and Qualitative Content Analysis according to Udo Kuckartz were identified as qualitative scenario development methods. Table 2 gives an overview.

Table 2: Main Approaches/Method Groups used in Future Scenario Development

Approach/ Method group	Short Description of the Procedure	Sources (whose knowledge is tapped)
Quantitative Scenario Development		
Cross Impact Analysis (e.g., INTERAX -Interactive Cross-Impact Simulation or IFS - Future Interactive Simulations)	Used where understanding the interrelations of assumed probabilistic events and trends from available data is essential. The method provides an initial analytical framework and a list of initial information on critical indicators/descriptors. These are used to consider and evaluate the impact of multiple linked future-scenario components on each other. The latter is done by experts through calculating and assessing probability estimates and system properties.	Expert knowledge from trend data
Trend Extrapolation / Trend Impact Analysis (TIA)	Systematic approach used for the combination of statistical extrapolations based on historical trends and expert judgments about impacts of selected potential or probable future events, for example, through a Delphi study.	Experts (trend data and judgements)
Fuzzy Cognitive Map (FCM) Based Scenario Planning Approach	Fuzzy Cognitive Maps (FCM) are used for supporting decision making by analyzing cause-and-effect relationships between concepts (nodes, e.g., a state, factor, event, activity, objective, etc.). FCM extends normal cognitive maps by modeling complex chains of causal relationships through weighted causal links between concepts. The causal relationships are defined in expert panels.	Experts (trend data and judgements)
Qualitative Scenario Development and Analysis		
Delphi Study	The iterative process used to obtain consensus by collecting the judgments of an expert panel (e.g., likelihood or expected development time) on future topics or scenarios or using a series of questionnaires interspersed with multiple feedback and discussion rounds. The procedure is anonymous and can be written or online-based as well as staggered or real-time.	Experts (judgements)
Matrix and Storylines - Approach	Key drivers of change are identified and then storylines, i.e., qualitative and descriptive images of future worlds, are written up by experts. The stories are framed around two axes that reflect alternative future world orientations (e.g., in environmental studies: regional versus global strategies on axis 1, and liberalization vs. regulation policies of environmental issues on axis 2).	Experts (scenario analysts) write up the future narratives. Infrequent involvement of stakeholders/ laypeople in the design of the narrative. Narratives are often communicated to broader audiences and "the general public".

Science Fiction Prototyping (SFP)	Science Fiction Prototypes are hort works of fiction that are grounded in scientific fact. Science Fiction Prototyping then is a process methodology where SFPs are crafted in workshops. Here, participants first choose the technology/science/issue to explore, explain it, and build up the SFP world (people, location). Using creativity methods, they then explore in the SFP world, the consequences of a failure in that technology (a scientific inflection point), the human reaction to the events that happen because of this failure, and finally a moral lesson about what was learned. Then, based on the learnings about the powers and limitations of science and technology and people's desires, they craft an actionable vision for a future that the participants can build, with ways to meet those desires.	Scientific or technological experts craft and explore the SFP. Researchers often communicate narratives to a broader audience.
Analysis of Science Fiction Novels and Films	Qualitative content analysis of science fiction novels and/or films to identify precursors for coming developments or warning signals.	Experts: Authors of novels or screenplays (In films: Artists and art directors)
Flash Fiction Stories	Laypeople representing future consumers or users write flash fiction stories (150-300 words) in creative writing workshops under time pressure (2-5 minutes) about the topic to be explored. There is no fact-based introduction to the topic. After a warm-up, there are three rounds of creative writing. For each round, participants receive a guiding question, e.g., 1) What the protagonist's world looks like in 2057 under the condition that specific technology is used; 2) a good and 3) a bad day in which the protagonist uses the technology). The stories are then analyzed with qualitative content analysis to identify envisioned future scenario clusters or use cases.	Laypeople (consumer/ users/ employees/ regional stakeholders)
Qualitative content analysis according to Udo Kuckartz	Qualitative content analysis according to Udo Kuckartz is an evaluation method that analyzes text material systematically and rule-guided. It distinguishes between three basic forms: content-structuring, evaluative and type-forming. Thus, three different evaluation possibilities are offered at the same time and one has the possibility to commit oneself to one form or to combine the forms, depending on the interest in knowledge.	

As part of the literature review, the project team looked at their respective countries first to determine which methods are being used within industries and at educational institutions. The team found a limited number of industries and institutions focusing on long-term future forecasting. The methods found are listed in table 3. 19 curricula in STEM education focusing on long-term future forecasting (table 4) and 15 training courses concentrating on futurology (table 5) were identified.

TABLE 3: METHODS USED IN INDUSTRY

Name of the company	**Country**	**Link to the literature or the case study of the company**	**Short description of the case**
Immersive Displays Ltd	UK	https://doi.org/10.1016/j.futures.2013.03.009	A Science Fiction Prototyping workshop inspired Immersive Displays to develop a new product: a desk with Virtual Reality to

			give students with online teaching the feeling of being in the classroom. The SFP workshop was designed to look into the nature of education in 2050 and resulted in a story on which the new product is based. In the story, the product was called ePods, described as "small cocoons" with "invisible technology" including "immersive mixed reality and sophisticated AI," implying that the user will be transported to another reality. Based on that story, an advertisement was developed, considering business and technical aspects. The company Immersive Displays tried to develop the product by taking a more pragmatic view of how it could be produced.
Swiss railway (SBB)	Switzerland	https://www.researchgate.net/publication/332948080_WHAT_CAN_WE_DO_FOR_YOU_FAR-FUTURE_MOBILITY-RELATED_CUSTOMER_NEEDS	Swiss railway SBB funded the research project to identify far-future (in 2057) customer mobility needs of the future working population and different customer groups. Scenarios were developed in four public workshops by asking the participants to write a flash fiction story about the general environment in which the protagonist lives in 2057 and how the protagonist travels to work and leisure time. Four different stories/scenarios were developed that were different from the Delphi study, also funded by the SBB research fund, in that way that it had an additional disruptive scenario.
Shell	UK	https://www.shell.com/energy-and-innovation/the-energy-future/scenarios.html	Shell is using its own developed scenario method to plan for the future: 1) Identification of driving forces of change affecting the future 2) Distinguish driving forces from predetermined elements and critical uncertainties 3) Creation of two-three scenario narratives through dialogue between members of the scenario team by some questions They use the method to e.g., create scenarios about energy transformation or what specific countries or the EU might need to do to get climate-neutral by 2050.
Rolls Royce	UK	https://sloanreview.mit.edu/article/using-scenario-planning-to-reshape-strategy/	Idea was to catalog significant factors that might affect Rolls-Royce by the year 2040 and to develop a set of strategic questions. 3-Day Workshop: 1) Research about relevant topics for the future 2) Presentation about findings 3) Division of Multi-disciplinary group into subgroups to create scenarios 4) Presentation and integrating of scenarios 5) Meeting to review and critique the scenarios with predefined questions

Royal Society of Chemistry	UK	https://www.rsc.org/about-us/our-strategy/future-of-the-chemical-sciences/	Came up with scenarios for the future of chemical science; describe approach as follows (1) identification of trends (2) define themes that may imply future changes (3) identify weak signals to challenge conventional thinking (4) develop plausible scenarios and understand possible implications for the future
Copenhagen Institute for Future Studies	Denmark	https://cifs.dk/our-projects/	Copenhagen Institute for Future Studies work with several companies for long-term future planning. Examples include the company NRK Norwegian public service provider of radio and TV or electronics and engineering company Brüel & Kjær A/S.
Creative Science Foundation	USA	https://creative-science.org/	Offers services for LTFS
Audi	Germany	https://www.interaktive-technologien.de/projekte/kobelu	Context-aware learning environment for education and training (Adaptive systems, Gamification, ...)
Uni Ulm	Germany	https://www.uni-ulm.de/med-anatomie/lehre/digitales-lernen/mymimobile/	Microscopy when and where your time allows - MyMi.mobile makes it possible to learn microscopic-anatomical content web-based using high-resolution, virtually microscopable and fully annotated histological specimens. This learning platform was operated by the Institute of Molecular and Cellular Anatomy at the University of Ulm, Germany.
HEAG mobilo GmbH	Germany	https://www.interaktive-technologien.de/projekte/indago	The inDAgo project is developing the inDAgo Assistant, a personalized multifunction device and mobile application that users carry with them. The device allows access to various data sources, information and navigation services that are tailored to the target group and adapted to individual requirements.
Merck AG	Germany	https://www.uid.com/de/aktuelles/discovery-sprint	One team. Five days. In one room. One week to analyze a problem, develop ideas, prototype and test them. That's the classic Google Ventures Design Sprint according to Jake Knapp. In times of Corona, our sprint with Merck* called for flexibility and creativity.
Autodesk	USA	https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7543426	Use of SFP to answer questions about future technologies in a more relatable, and impactful way. The focus was to determine the future of design

TABLE 4: STEM CURRICULA ON LONG-TERM FUTURE FORECASTING

Name of the institution (focus on STEM education)	**Country**	**Link to the course/curriculum**	**Field of studies**

Freie Universität Berlin	Germany	https://www.ewi-psy.fu-berlin.de/v/master-zukunftsforschung/index.html	Educational science and psychology
SRH Fernhochschule – The Mobile University	Germany	https://www.mobile-university.de/master-fernstudium/innovation-zukunftsforschung/	Economy / Management
Hochschule für angewandtes Management FH	Germany	.fham.de/studiengaenge/master/angewandte-zukunftsforschung/	Business Psychology and Business Administration
Technische Hochschule Ingolstadt	Germany	https://www.thi.de/studium/studienangebote/details/global-foresight-and-technology-management-msc/	Technology Management
Technische Hochschule Brandenburg	Germany	https://wirtschaft.th-brandenburg.de/studium/masterstudiengaenge/technologie-und-innovationsmanagement-und-entrepreneurship/	interdisciplinary: Engineering and natural sciences, computer science Industrial engineering
Technische Universität Carolo-Wilhelmina zu Braunschweig	Germany	https://www.tu-braunschweig.de/studienangebot/technologie-orientiertes-management-master	Technology-oriented management
FH Bielefeld University of Applied Sciences	Germany	https://www.fh-bielefeld.de/studiengaenge/sozialwissenschaftliche-transformationsstudien	Social Science Transformation Studies
Hochschule Stralsund	Germany	https://www.hochschule-stralsund.de/inno/	International Innovation Management
Hochschule für Wirtschaft und Umwelt Nürtingen-Geislingen (HfWU)	Germany	https://www.hfwu.de/en/znx/#c12875-2	Future trends and sustainable management (MBA)
Pennsylvania State University	USA	https://bulletins.psu.edu/university-course-descriptions/undergraduate/esc/	Engineering
Fordham University	USA	https://bulletin.fordham.edu/courses/phys/	Physics
Lund University	Sweden	https://kurser.lth.se/lot/course-syllabus-en/09_10/TEK065	Engineering
Epoka University	Albania	https://eis.epoka.edu.al/curricula/syllabus/10311/1/32	Architecture
Stanford University	USA	https://web.stanford.edu/class/archive/me/me297/me297.1064/coursework/syllabus.html	Engıneering
Rutgers University	USA	https://history.rutgers.edu/docman-docs/undergraduate/2064-506-233-pietruska-sp22/file	STEM in Society?
Yeditepe University	Turkey	https://eng.yeditepe.edu.tr/en/industrial-engineering-department/dersler/4594	Engineering
Universidad de Externado	Colombia	https://www.uexternado.edu.co/en/programa/school-of-management/maestria-pensamiento-estrategico-prospectiva/	Management
Georgia School of Technology	USA	https://dm.lmc.gatech.edu/wp-content/uploads/2016/11/LMC-6215-AI-AND-SCIENCE-FICTION.pdf	Computer Science: Artificial Intelligence
The Hong Kong Polytechnic University	Hong Kong	https://www.eie.polyu.edu.hk/prog/syllabus/EIE1D03.pdf	Computer Science: Artificial Intelligence

TABLE 5: TRAINING COURSES ON FUTUROLOGY

Name of the training institution	**Country**	**Link to the course**	**Short description of the course and how it related to FIT4FUTURE**
Arizona State University	USA	https://emerge.asu.edu/about/	It is a three day workshop or festival that brings together people from various fields under a specific theme (e.g. in 2016: The Future of Sports 2040) with various of activities
University of Stuttgart	Germany	https://www.energyscenarios.kit.edu/index.php	ENERGY SCENARIO SCHOOL: The Helmholtz Graduate School "Energy Scenarios" offers a structured 3- year training programme for international PhD students in the field of energy scenarios. Researchers will gain comprehensive knowledge of the construction techniques of scenarios, the system boundaries in the energy sector, as well as be able to make in-depth valuations of energy scenario assessments and their impacts on decision-makers, politicians, population etc.
University of Southampton	UK	https://www.southampton.ac.uk/courses/modules/math6011#overview	MATH FORECASTING: Learning Outcomes-->Having successfully completed this module you will be able to: 1) Formulate time series models and construct Python-based versions. 2) Produce well-structured assignment reports describing problem formulation and solution. 3) Appreciate both the capabilities and the limitations of such computer-based techniques. 4) Use Python functions built in various libraries to fit and analyse such models to data
Shijiazhuang University	China	S. Zhang and V. Callaghan, "Using Science-Fiction Prototyping as a Means to Motivate Learning of STEM Topics and Foreign Languages", 2014	One hundred and two students attended the Computer English class at Shijiazhuang University in the autumn term of 2013. They were divided into 17 groups. Each group was asked to design a science fiction product using the creative science approach, based on computer technology, and using English vocabulary to describe the product and how it might influence human life in the future.
University of Oxford	UK	https://www.sbs.ox.ac.uk/programmes/executive-education/campus-open-programmes/oxford-scenarios-programme	Oxford Scenarios Programme: 5 days programme. It covers a broad range of themes, including: What can we influence in the context of our organisation and what will most influence success in the future? What is the relationship between strategic planning and scenarios? How do I design a fit-for-purpose scenario intervention? How do scenarios and forecasting relate to each other? Who does what in scenario practice?
WORLD FUTURES STUDIES FEDERATION	Iran?	https://wfsf.org/introductory-3-unit-course-outline-iran/	Introductory Futures Studies Course consists of three units, which build upon each other in a logical sequence, each addressing one of the following major themes: 1) Foundational Ideas and Concepts in Futures Studies; 2) Introducing Key Approaches and Methodologies; 3) Exploring Application through Case Studies.

Polidesign	Italy	https://www.polidesign.net/en/formazione/business-design/corso--designing-sustainable-futures#tab_didattica	DESIGNING SUSTAINABLE FUTURES: Designing Sustainable Futures is an eight-week intensive program to develop the skills and mindset of practitioners who are passionate about building a better world. It seems to address a broader audience.
Dublin City University	Ireland	https://creative-science.org/events/ctyi-2016/	Teaching Children and Young Adults about Short Fiction through SFP: in collaboration with The Centre for Talented Youth of Ireland. The summer school is not specifically directed to STEM students, but it is open to a broader audience. The summer school 82016) explores "the use of freewriting as a means of encouraging and capturing imaginative thoughts. Freewriting is the writing method which involves no pre-considered thought and allows ideas to become concrete sentences without the fear of judgement or correction, criteria that are shared with brainstorming methods. After twenty minutes of quiet and contemplative freewriting, each member of the class was asked to present a chosen invention."
AIGA Portland	USA	https://portland.aiga.org/event/science-fiction-prototyping-a-how-to-workshop/	Practical professional development informal workshop and networking opportunity where author and consultant Corey Pressman will introduce the history and utility of science fiction prototyping and show us how to explore, test, and communicate new products, experiences, and services.
Nordic Center for Sustainable Healthcare	Norway	https://www.nordicshc.org/show-the-calendar/92.html	Using shared health data and LTFS, the workshop aims at envisioning what an innovative and connected Nordic region would look like if health data was shared seamlessly across public-private partnerships in the region
North Carolina State	USA	https://www.lib.ncsu.edu/workshops/forecasting-future-writing-speculative-micro-fiction-1	In this one day workshop, participants learn more about Futures Thinking while developing 'forecasting skills' by writing speculative micro-fictions on a topic of choice
Introduction to Future Design: Anticipate Tomorrow	USA	https://www.domestika.org/en/courses/3241-introduction-to-future-design-anticipate-tomorrow/units/11837-anticipating-possible-futures/lessons/35804-imaginaries-of-the-future	Course on how to design long term innovative solutions
4th Sustainable Development Goals Virtual Youth Summer Camp Syllabus and Participant Guide	United Nations	https://sdgs.un.org/sites/default/files/2020-09/Syllabus%204th%20SDGs%20Virtual	Summer camp wich trains youth in LTFS related skills: The objectives of the SDGs Youth Virtual Summer Camp will include, but are not limited to the following:

		%20Youth%20Summer%20Camp_revised_14July20_participants.pdf	• Build and enhance knowledge of selected youth on the 2030 Agenda for Sustainable Development; • Foster youth leadership skills, with design-thinking, critical-thinking, and engagement through dialogues and exercises on SDG implementation; • Provide opportunities for networking among youth; and • Expand the host institution's partnership with youth leaders for the SDGs
Emergencia Climática: Escenarios Sociales de Futuro (Clikate emergency, Future Social Scenarios)	Spain	https://teachersforfuturespain.org/curso-emergencia-climatica-escenarios-sociales-de-futuro-ii-edicion/	A new edition of this online training of great interest begins for professionals who want to open the educational center to their environment and turn it into a dynamic element of the eco-social transition.
Universität Bremen	Germany	https://www.edukatico.org/de/online-kurs/methoden-der-zukunftsforschung	This online lecture series provides an introduction to futurology. Included are, among others, scenario techniques, chaos theory and trend research.

3.2. Conclusion From Desk Research

This desk research provided the project team with crucial insights into existing data. Reviewing literature concerning curricula offerings on future forecasting available at educational institutions included a mapping of methods applied in future forecasting in the technology industry. This research investigated mainly European countries to determine what methods are being used within industries and training programs. Findings show that scenarios are being used but that there are not that many cases where LTFS are being used within industries. For industries, we found 12 cases out of which 6 were identified using scenario techniques.

The research included exploring existing curricula and training programs in LTFS. According to edurank.org there are around 1100 STEM universities in Europe, out of which our research team found 19 educational institutions with curricula focusing on long-term forecasting and 15 training courses on futurology in general. Considering the large number of educational institutions and programs available in Europe, there does not seem to be too many programs focusing on LTFS. It is therefore essential to encourage innovative learning and teaching practices through the development of a curriculum focusing on long-term future scenarios. This underpins the preliminary research done in the proposal stage of FIT4Future.

Methods specified in this desk research were taken into consideration for the design of the survey and interview methodology and will be relevant in the curriculum development.

4. Field Work Results

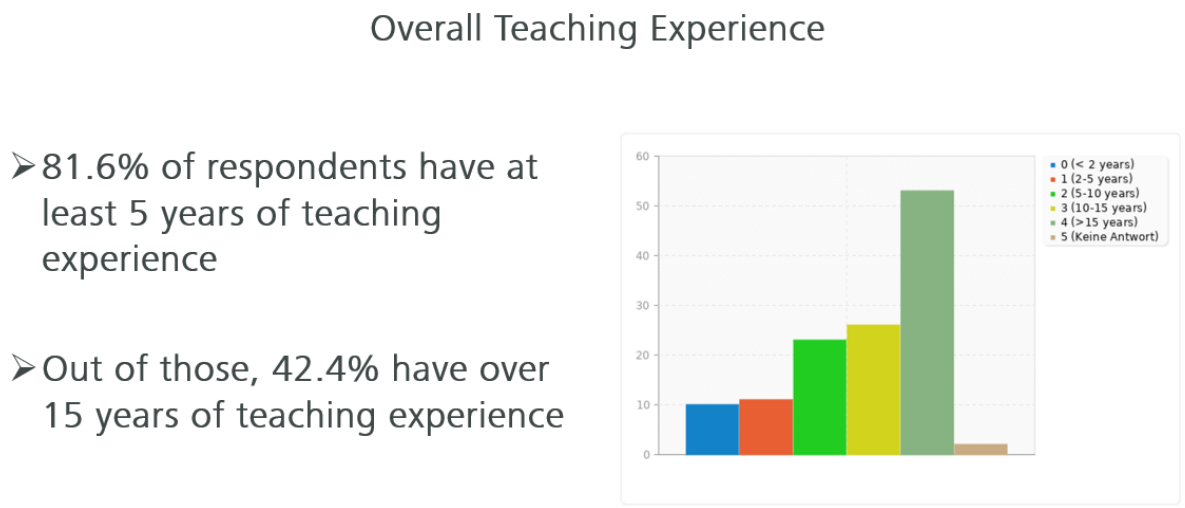
The field work in the FIT4FUTURE project consists of a survey and interviews with specific guidelines on how it will be conducted. The content and structure of the survey and interviews were based on the outcomes of the desk research. Based on findings from the desk research, the FIT4FUTURE

project team conducted a survey questionnaire to investigate and evaluate the current state of knowledge of HE teachers on analyzing and predicting future developments in the context of their teachings. The survey questionnaire was distributed among HE teachers of all four partner universities and received responses from 125 participants of which 45 were from Germany, 25 from Portugal, 24 from Denmark, 23 from Turkey, and 8 from various other locations.

The quantitative data was complemented with qualitative interviews. Each of the four countries involved in this research project were to conduct interviews with 5 of the HE survey respondents from their country during the months of August to October 2022. A total of 22 interviews were conducted, recorded and transcribed. The interviews lasted between 20 and 45 minutes. Individual country reports from EGE, HDM, SDU and UBI have been added to the annex section of this report.

4.1. Survey Analysis

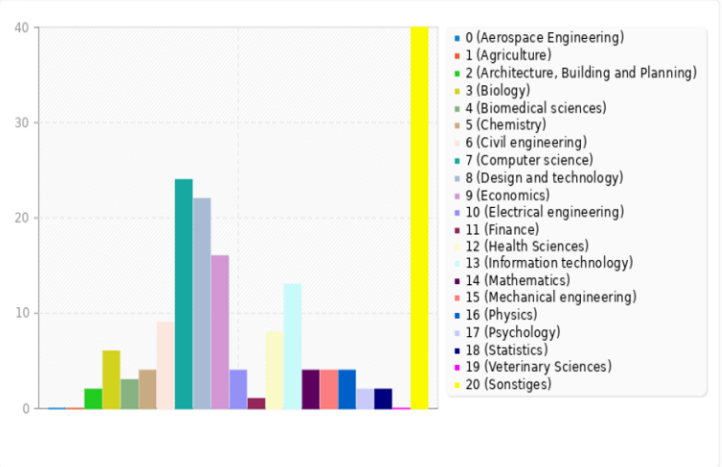
The FIT4FUTURE Survey showed that 84% of survey respondents are between 30-60 years of age and mainly from the four countries, Denmark, Germany, Portugal, and Turkey that are responsible for conducting the FIT4FUTURE research project. 81.6% of HE respondents have at least 5 years of general teaching experience with 42.4% of those having over 15 years of experience.



Respondents are mainly teaching STEM disciplines in the life sciences, physical sciences, engineering, mathematics, computer science and health sciences. 54.4% of respondents indicated having taught their STEM subjects for more than 10 years.

Main Subject Areas Taught

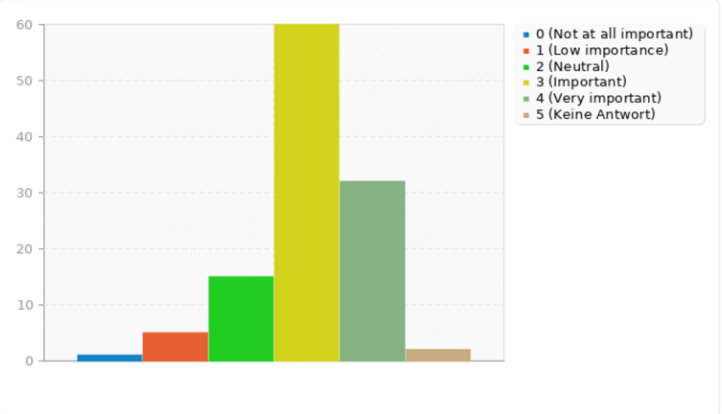
- STEM disciplines:
  - life sciences
  - physical sciences
  - engineering
  - mathematics
  - computer science
  - health sciences



84.35% of survey respondents have been looking at future developments for the subjects they teach. With respect to the subjects they teach, 47.83 % would like to look 5-10 years into the future while 19.13% are interested in an even longer time horizon of more than 10 years. 52.17% find long-term future developments important for their teaching while 27.83% consider it very important.

Importance of Long-Term Future Developments

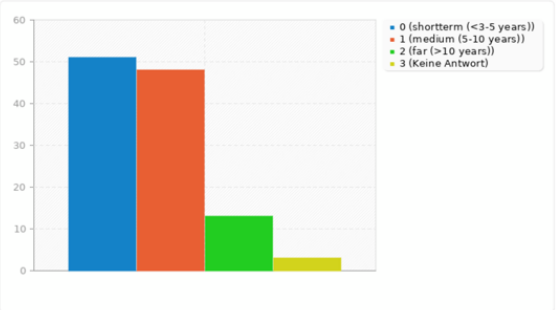
- 52.17% of respondents find them important for their teaching
- 27.83% consider them very important



Current methods used are allowing 44.35% of respondents to look at the near future and 41.74% at a 5-10-year time horizon. 53.91% are not using statistical data for showing or discussing future developments while 44.35% are currently using it. 66.09% have indicated using scenarios for showing or discussing future developments.

Current Methods Used

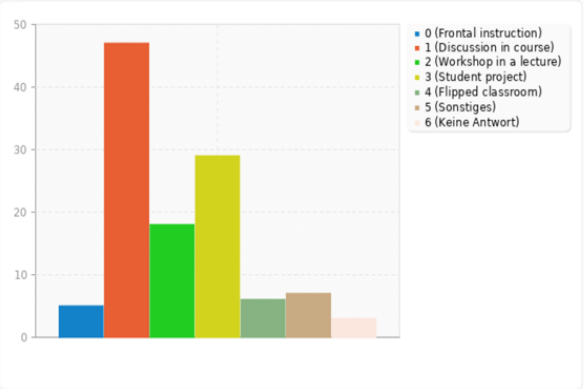
- 44.35% to look at the near future
- 41.74% look at a 5-10-year time horizon



Didactical context used for discussing future developments include discussions in courses (40.87%), student projects (25.22%), and a workshop in a lecture (15.65%). Frontal instruction is being used by 4.35% of respondents and the flipped classroom approach by 5.22%.

Didactical Context Used

- Frontal instruction (4.35%)
- Flipped classroom approach (5.22%)
- Discussions in courses (40.87%)
- Student projects (25.22%)
- Workshop in a lecture (15.65%)



With regards to their knowledge level on such methods as Cross Impact Analysis, Trend Extrapolation/Trend Impact Analysis, Fuzzy Cognitive Maps, Delphi Studies, Matrix and Storylines, Science Fiction Prototyping, Analysis of Science Fiction Novels and Films, and Flash Fiction Stories, over 65% of respondents indicated not being familiar with the methods.

- Most respondents (at least 65%) are not familiar with these methods
  - Cross Impact Analysis
  - Trend Extrapolation / Trend Impact Analysis
  - Fuzzy Cognitive Maps
  - Delphi Studies
  - Matrix and Storylines
  - Science Fiction Prototyping
  - Analysis of Science Fiction Novels and Films
  - Flash Fiction Stories

- Methods are being used in:
  - Lectures
  - Discussions
  - Student projects
  - Workshops
  - Research

Knowledge levels of those having used each of the methods vary, with some respondents stating having good to expert level knowledge when using the Cross Impact Analysis (4.95%), Trend Extrapolation/Trend Impact Analysis (14.85%), Fuzzy Cognitive Maps (11.88%), Delphi Study (31.68%), Matrix and Storylines (23.76%), Science Fiction Prototyping (8.91%), Analysis of Science Fiction Novels and Films (15.84%), and Flash Fiction Stories (8.91%). Respondents stated using those methods in lectures, discussions, student projects, workshops, and research. 85.71% of survey respondents indicated an interest in wanting to learn more about LTFS.

4.2. Survey Results

Results from the survey show that 84.35% of survey respondents have been looking at future developments for the subjects they teach, while others stated that they are planning to or have not been using future developments in their teachings yet. Current methods being used are allowing the majority of HE teachers to look at the near future or a 5 to 10-year time horizon only. 19.13% are interested in looking at a long-term horizon of more than 10 years for the purpose of their teachings. So far, only 11.30% of respondents have been using methods that enable them to look more than 10 years into the future; however, 80% of respondents indicated that they consider long-term future developments relevant to their teaching. 66.09% have been using scenarios for showing or discussing future developments, but there is a lack of using statistical data in teachings. 53.91% have indicated that they do not use statistical data for their teaching, mainly due to a lack of knowledge of these methods.

Knowledge of future developments are significant within teaching STEM disciplines. While many respondents are not too familiar with foresight methodologies, they indicated wanting to learn more about LTFS for their teachings. Apart from some teaching domains requiring a shorter time frame, most respondents indicated wanting to look at a time horizon of more than 10 years in their teachings; therefore, confirming the need of this research project.

4.3. Interview Analysis

A total of 22 interviews with HE teachers were conducted to capture the current state of knowledge and practice on analyzing and predicting future developments in the context of HE teaching. The targeted number of 5 participants per country has been reached. Table 6 below provides an overview of the number of participants in each of the countries:

Table 6: Interview participants overview

Country	Number of Interview Participants
Denmark	5
Germany	5
Portugal	7
Turkey	5

Interviewees were asked about their field of teaching and amount of experience. This task aimed to acquire more information about the interviewees' use of data about future developments in their teachings, the context and didactical format, as well as methods used to predict or analyze future developments in their teachings. The following table 7 shows a summary of the interview questions as well as responses of the interviewees from Denmark, Germany, Portugal and Turkey:

Table 7: Summary of interview questions

FIT4FUTURE: Empirical Findings from Interviews	
Teaching Experience	● 1 and 10 years of teaching experience in engineering courses (Denmark) ● 10 to 15 years of teaching experience in the areas of publishing, business, and entrepreneurship (Germany) ● 2 to 25 years of teaching experience in the area of management, entrepreneurship, computer science, healthcare sciences (Portugal) ● 8 to 17 years of expertise in engineering, education and instructional technology (Turkey)
Field of Teaching	● Aero and Space Science; Science Education; Technology and Entrepreneurship; Climate Change; Technology Markets and Diffusion; Hype Cycles of Emerging Technology; Entrepreneurship.
Use of data about future developments	● Teachers use or plan to use data about future development in their courses due to the nature of their field of teaching.
In what context	● Data in the shape of charts or trends; projections and scenarios about the future; methods to develop future scenarios.
In which didactical format	● Teachers combine several methods in their courses: ○ Frontal traditional lectures are being combined with exercises (group work, workshops, expert interviews, lab exercises, flash fiction writing, science fiction, computer based modeling programs, case studies, assignments, and research) ○ Flipped classroom elements are being utilized to a lesser extent

Reason for using future developments	● To predict future events to adapt to a future situation possibly benefitting different stakeholders ● Increase students' awareness and prepare them for future scenarios ● Teach students to think outside the box and be creative; educating them on interpreting and analyzing data ● Help students in its understanding of lecture contents ● Personal interest in the topic
Students' Reaction	● Mostly positively with curiosity, enthusiasm, excitement, and increased motivation ● Some worry due to the abstract nature of the method
Barriers	● Technical problems when introducing future scenarios ● Students not understanding concepts or aim of a scenario ● Students' lack of ability to think outside the box or independently use data ● Practical issues like time constraints, different language and levels of previous experience
Benefits of Teaching Future Scenarios	● Increased motivation and out-of-the-box thinking ● Provide students with an idea about their future competition, how to apply scenarios for different technologies, and the significance of making educated predictions ● Importance of having realistic scenarios by basing scenarios on facts or experts' opinions
What is important for using Future Scenarios	● Teachers' methodological and technical skills ● Theoretical knowledge ● Future scenarios for preparing students as environmentally responsible individuals
Familiarity of future development methods	● Not all of the teachers are familiar with each of the methods used for predicting future developments ○ A lack of pedagogical knowledge of methods ○ Using current trends to develop scenarios due to unfamiliarity with methods
Methods used	● Narrative ● Delphi Studies ● Cross Impact Analysis ● Trend Scenarios ● Flash Fiction story writing ● Traditional lab methods ● Research of scientific literature ● Pre-Mortem approach
Quantitative Statistics vs Qualitative Scenarios	● Most teachers use mainly quantitative methods ● Some use a combination of qualitative and quantitative scenarios, depending on the subject
Process for constructing future predictions	● Collecting current information, analyzing it, and then generating future scenarios ● Using created scenarios to then develop strategies ● One teacher is having students work in groups to build their own scenarios

Relevant time horizon	● All teachers stated a need for different time horizons depending on the subjects they are teaching or the methods they are using ○ Most teachers have been focusing on near-present scenarios (2-5 years) ○ Some teachers have been focusing on a longer time horizon (5-10 years and 10-15 years) ○ Due to the changing market and technological developments, some teachers indicated that a longer time horizon is not very realistic in some areas
Advantages and disadvantages of methods used	● Advantages: ○ Methods used are rated as simple, realistic, and starting from actual data ○ Increased motivation; giving students a perspective; increasing creativity; developing argumentation skills ○ Students can apply knowledge; learn critical thinking; create something useful; better judge potentials and risks ○ Improve students' competences; allow a more holistic view of problems and tools they can use to approach those problems ● Disadvantages: ○ Teachers often experience a lack of time ○ Sometimes not considering disruptive events or having to neglect certain aspects to focus on others ○ Students' different knowledge levels need to be taken into consideration ○ Results of the trend analysis can be changed due to sector developments and lack of student skills ○ Students' imagination can limit a fully and immersive experience of future scenarios ○ When methods are being used that students do not enjoy or lack background knowledge in, their level of creativity declines
Outcome of method	● Methods are being taught so they can be easily remembered and aim to provide students with a deeper understanding of the relevance of thinking about the future and with an opportunity to create something of value ● Provide students with the tools they need to produce more "nuanced" views about the future to be more credible and offer more interesting perspectives ● May ensure that given scenarios are comprehensible and explainable enough with the related topic(s) along with a realistic interpretation
Gain from methods	● Students not only gain experience and people skills but also learn to be creative, solve problems, and research information ● Students gain employability, context, and the ability to communicate and spread knowledge about potential futures ● Students can improve their communication skills about the potential future and realise so far unused opportunities ● Students learn how to make narratives about the future, which might be useful in their future work
What interviewees would like to learn more about	● All teachers expressed an interest in wanting to learn more about different methods in order to improve their teaching and methods

	• Some wanting to incorporate more future scenario development methods in their lessons

4.4. Interview results

Findings show that most interview respondents have been using data in the shape of charts, trends, projections, and scenarios about the future, while others have been using methods to develop future scenarios. Most teachers have been focusing on near-present scenarios (2 to 5 years), with some indicating focusing on a longer time horizon of 5 to 10 years and 10 to 15 years. Since the majority of interviewees are not familiar with the methods used for predicting future developments, mainly due to a lack of pedagogical knowledge of the methods, they have been making use of current trends to develop future scenarios. Most teachers stated using mainly quantitative methods; some a combination of qualitative and quantitative scenarios, depending on the subject. While some students are struggling with understanding the concepts or aim of a scenario, most students have reacted positively to learning about future scenarios. Since the abstract nature of methods and students' lack of imagination can limit a fully and immersive experience of future scenarios, teachers need to ensure that given scenarios are comprehensible and explainable enough to provide a realistic interpretation. Interviewees indicated that they would like to use LTFS in their teachings, but due to its complexity, they have not made much use of them yet.

4.5. Conclusion From Field Work

The vast majority of survey respondents were HE teachers from Germany, Denmark, Portugal and Turkey, the partner countries of the FIT4FUTURE project. The high level of participation from HE teachers lets us conclude that the field work was successful. Interviewees added qualitative data about their needs to this research project. The results from the survey were analysed and contrasted with the interviews from a smaller sample of HE teachers who participated in the survey. Although many respondents indicated not being too familiar with foresight methodologies, they emphasized wanting to learn more about LTFS for their teachings. Apart from some teaching domains requiring a shorter time frame, most respondents stated wanting to look at a time horizon of more than 10 years in their teachings.

Due to the successful dissemination of the FIT4FUTURE survey and subsequent interviews, the data collected by the partners during this research phase provided an excellent background from which to develop a curriculum framework. Findings have revealed interesting results that justify the need for the learning content to be developed.

5. Conclusions from Research

This research aimed to investigate methods for predicting future development and the context in which they are being used. Using qualitative data in the form of a survey and interviews helped determine the current state of knowledge of HE teachers. Research compared existing curricula and offerings of HEIs and considered relevant continuous training offers as well as case studies in the industry. During the analysis of the competence matrix and curriculum, all collected data was analyzed to understand HE teachers' and students' expectations in more depth. Data was analyzed from a quantitative as well as qualitative perspective obtained in the desk research, survey, and

interviews. Findings show scenarios being used but with limited cases of LTFS, mainly due to its complexity. It was, however, indicated by respondents that they would like to use LTFS in their teachings. Therefore, the findings confirm the preliminary research and needs analysis conducted at proposal stage and assess more profoundly the needs of STEM students for having a curriculum on long-term future forecasting and the training needs of HE teachers teaching such a curriculum.

The FIT4FUTURE learning program is meant to fill the gaps identified in the literature review and research analysis. Data collected in the desk research, survey and interviews is being used as a basis for conducting the mapping of the educational landscape for HE teachers. This training mapping exercise was conducted with the input of all project partners and will outline the curriculum to be developed to fulfil the objectives of the FIT4FUTURE project. The content of the modules needs to be designed to enable HE teachers to enhance their skills and competencies on teaching LTFS. Gaps and needs for developing LTFS for HE teachers were taken into consideration to define the learning outcomes as part of the training mapping exercise.

6. FIT4FUTURE Competence Matrix and Curriculum

In task 3 of PR1, all the collected data was analysed from a quantitative as well as qualitative perspective obtained in the desk research, survey and interviews to understand HE teachers' and students' expectations in depth. Clear gaps have been revealed, which the FIT4FUTURE learning program is set out to fill, and recommendations and conclusions were made for the development of the competence matrix and curriculum.

6.1 Training Mapping Exercise

The FIT4FUTURE partners met in Badajoz in October 2022 to conduct a training mapping exercise to determine teachers' and students' needs and to collect ideas to fulfill training requirements. Based on the analysis of the training mapping exercise, the consortium discussed the learning content and identified suitable topics for the curriculum. Those were pinpointed based on the identified existing training offers and its subsequent trends and limitations. The training mapping exercise resulted in the following needs for and requirements on the FIT4FUTURE curriculum:

Upskilling teachers

- No knowledge about what LTFS is and why it is important
- How to act when teaching LTFS online
- Get a holistic view on problems
- Ability to define and draw scenarios
- Reduce time preparing 4 courses
- Assistance to practical problems
- Non-english learning material
- Adaptive content to learner needs

Upskilling students

- Enhance the ability to think outside the box and creative thinking
- Grow curiosity
- Realise scenarios for different technology applications

- Realistic interpretation of available future scenarios
- Improve student communication skills about future
- Increase students awareness on LTFS
- Prepare students for future scenarios
- Promote students baseline
- Enable students to realise unused opportunities and scenarios
- Prepare students for future scenarios
- Promote students baseline
- Derive strategies from scenarios and adapt to future situations and future competition
- Ability to filter relevant information

General requirements

- Transfer knowledge and information on LTFS
- Usage of statistical data in scenarios
- Computer based modelling programs
- Complementary activities
- The timeframe of LTFS methodology should be short-term (3-5 years), midterm (5-20 years) as well as long- and very long-term (50-200 years) with the ability to divide the time horizon into smaller pieces.

Why LTFS?

- Understand importance of future scenarios
- Sensibilise why students need LTFS skills
- Prepare for the apocalypse
- Sustainable strategies require good foresight & planning
- Avoid wrong and expensive investments
- Uncertain world requires foresight capacities
- Ability to build realistic scenarios

Pedagogy

- Provide pedagogical knowledge regarding methods
- Tactics on how to improve students imagination
- How to deal with pedagogical challenges
- Classroom dynamics

Theory

- Establish the basics (awareness)
- Provide theoretical knowledge

Within the training mapping exercise, the following ideas for the FIT4FUTURE curriculum have been developed:

Basics

- Intro Lesson: What is future forecasting and introduction to theory
- Lesson: Why LTFS is important in today's labor market

Tutorials

- Howto: What is it?

- Tutorials on individual methods
- How to use statistical data
- How to use different technologies
- How to make narratives about future
- How to develop scenarios
- How to raise interest of students
- How to develop LTFS with students with what method
- Assignments for students

Teaching Techniques

- Flipped classroom activities
- Basing scenarios on statistics
- Team working for ideas on future scenarios
- Usage of creativity techniques to engage students

Experience Videos

- Testimonials from teachers
- Cases and examples: The good & the bad
- Teaching examples
- Experimental personas
- Checklists and guidelines
- Computer based modelling programs
- Narratives
- Slides?

Resources

- Build a sense of community and allow to share contents
- Automatic scenario generator based on KI
- Provide statistical data sources in different languages

Context

- Define fields by uncertainty
- Small steps for future scenarios
- Sector-/area-based methods
- Expand to other areas than technology like climate
- Create a hubs divided by tools and fields
- Correlate future scenarios with industry
- Scenarios orienting to Sustainable Development Goals (SDG) of UN

6.2 FIT4FUTURE Curriculum Framework

The FIT4FUTURE Curriculum Framework was developed based on the previous large scale mapping exercise of the current curricula, the needs of HE STEM teachers and available educational contents. The framework outlines the training modules that address the gaps and focus on providing HE teachers with the adequate knowledge to better teach long-term future forecasting in their curriculum. The curriculum is set up with different modules that are practical and easy for HE teachers to use.

The consortium discussed the learning content and platform and agreed that it should have the following structure:

1. Introduction area: Basics

This area will contain presentation(s) with voice over explaining why LTFS is important and what the theory behind LTFS is.

2. Method area: Overview on LTFS methods

This part of the platform will contain in-depth descriptions and implementation examples and tricks of the following eight major LTFS methods:

- Trend Extrapolation/Trend Impact Analysis
- Flash Fiction Stories
- Analysis of Science Fiction Novels and Films
- Cross Impact Analysis (Simulation)
- Delphi Study
- Fuzzy Cognitive Map
- Science Fiction Prototyping

The learning material on each LTFS method/approach will contain the following elements:

- In-depth method/approach description: What is the method/approach about, time frame: (3-5 years, 5-10 years, longer than 10 years), where does it come from, how and for what purpose can it be used in teaching. The descriptions will also include links to additional publicly available material on the method: books, links, videos etc.
- Links to case study description (from experience area): Description of two examples/ cases of how the method was used in the industry or by public organisations that can later be used as teaching cases
- Links to teacher expert videos (from experience area): Short 3-5 minute videos in which a teacher explains how they use the method in their teaching
- Teaching material: Original teaching material that the teacher experts use in their teaching (e.g., their slides)

3. Experiences area

Two types of experience areas have been identified:

- Teaching experiences: Experiences from teachers with teaching or using LTFS methods in their sessions or classes. The idea is to ask interviewees who are good at certain methods to explain them in a video that we would then post on the website. 2 videos to be done per country. 3-5 minutes. We should also ask for slide sharing (teachers should share the slides that they use in teaching) → link the LTFS methods of section 2 LTFS methods
- Industry experiences: Description of the cases/examples from industry → these should be classified according to the identified LTFS method and link directly back to the corresponding section.

The teacher experiences are ideally videos; for the industry experiences, a specific case/example template will be developed.

4. Additional resources: Links to trend report sources

The need analysis in the survey and the interviews revealed that the teachers wish for links to additional resources that relate to long-term future scenario development in general and also to trend reports in local languages. The curriculum therefore provides links to data sources on pages that report trends about long-term future developments:

- English sources (such as Gartner)
- Local language sources (like TUIK for Turkey, or Zukunftsinstitut for Germany)

Technical platform

A Moodle based learning management system will be integrated to the FIT4FUTURE website that involves the learning materials divided into modules. Moodle is a very well-known learning management system, which is developed free and designed to support online courses with many opportunities to create interaction and collaboration between teachers and students. The opportunities such as ease of customization and ease of access are important for the FIT4FUTURE expectancies. The platform enables uploading and creating rich activities and materials (video, image, animation material to upload, discussion forums, assessment tools, surveys to create) as a module-based system. Being a user friendly and mobile friendly system, it will allow the learners to reach content from any mobile device, anywhere.

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8. Annexes

8.1. EGE Main Conclusions on Interviews

Five interviewees differed in terms of their experience in teaching, ranging from 8 to 17 years. They have expertise in engineering, education and instructional technology. Four teachers indicated that they use data for future development in their courses and justified their answer by mentioning the nature of their field. They indicated that they use such scenarios in teaching aero and space science, environmental education, technology and entrepreneurship subjects.

When using data for future scenarios, the teachers combine several methods in their courses: traditional lectures, workshops, and science fiction. Furthermore, one teacher indicated that they use computer based modeling programs for future prediction of the environment.

Teachers indicated different motivations for incorporating future developments with regards to their teaching field. The reasons included developing projects, increasing students' awareness, preparing them for the future scenarios.

Four teachers indicated that their students react positively to the incorporation of future scenarios in their teaching. They mention sparked curiosity, increased motivation of their students. However, one teacher mentioned that future scenarios should be used cautiously because students think that this method is abstract in nature. Teachers indicated that they have some technical problems when introducing future scenarios in their courses. The obstacles included but not limited to scenarios are mostly presented in English. However, teachers saw the benefit of future scenarios in increased motivation and preparation of the students for their future sectors. Two teachers indicate the importance of teachers' methodological and technical skills for covering future scenarios in their instruction. While one of them stressed the importance of theoretical knowledge, the other one

mentioned the importance of future scenarios in preparing students as environmentally responsible individuals.

Considering the methods teachers use to predict or analyze future developments in their teaching, three teachers indicated lack of pedagogical knowledge regarding the methods. While one teacher indicated that she uses quantitative methods the other mentioned that he uses mixed methods. Although the specific knowledge on methods are limited, four teachers use both qualitative and quantitative scenarios depending on the subject.

Considering teachers' answers, they all need different time periods to look into the future as it is more relevant to their subject areas. One of them mentioned that even if the time horizon is large it should be divided into smaller pieces, while another mentioned that current data could lead them to predict future scenarios. Due to the needs of his field, the teacher who is an instructional technologist stated that the far future definition has also changed. He mentioned that the 10-15-year period has decreased to 3-5 years because the developments in his field are relevant.

The teachers identify different advantages and disadvantages in their methods. As advantages they have listed increased motivation, giving students a perspective, increasing creativity, developing argumentation skills. The disadvantages included results of the trend analysis can be changed due to sector developments and lack of student skills.

8.2. HDM Main Conclusions on Interviews

The five interviewees with 10 to 15 years of teaching experience in the areas of publishing, business, and entrepreneurship all use data in the shape of charts or trends to make predictions about future developments, with one using methods to develop future scenarios.

Data about future developments is being used in different didactical formats. Frontal traditional lectures are being combined with group work, workshops, expert interviews, and research to have students develop their own scenarios. To a lesser extent, flipped classroom elements are being utilized.

Teachers' motives for focusing on future developments comprise of the need to simulate or predict what is going to happen in order to adapt to a future situation. Students are being taught to think outside the box, to be creative, and to read, interpret, and analyze data. Teachers emphasized their students' curiosity, excitement, and positive reactions towards understanding the changing trends for which new solutions need to be found. Teaching future scenarios allows teachers to provide their students with an idea about their future competition and the significance of making educated predictions. Teachers mentioned the importance of having realistic scenarios by basing scenarios on facts or experts' opinions. Most teachers have not experienced any barriers to introducing or building future scenarios as part of their teaching. The only barriers encountered were due to students not understanding the concepts or aim of a scenario as well as a lack of ability to think outside the box.

Not all of the teachers are familiar with each of the methods used for predicting future developments. Four of the teachers are using methods, such as Narrative, Delphi Studies, Cross Impact Analysis, and Trend Scenarios. One teacher is not familiar with the methods at all and mainly focuses on current trends to develop their scenarios. One teacher indicated using a method called the Pre-Mortem approach. Three of the teachers mainly use qualitative scenarios, while two are using a combination of both, qualitative scenarios and quantitative statistics. Teachers have been focusing on collecting current information first, then analyzing it before generating future scenarios. One teacher uses their created scenarios to then develop strategies.

All teachers mentioned a slightly different time horizon being relevant in their teaching. Teachers have mainly been looking at the near future in their teaching, ranging from 2 to 5 years while one teacher has been focusing on a longer time horizon of 10 to 15 years. Due to the changing market and technological developments, three of them indicated that a longer time horizon might not be very realistic. One teacher stated that 3 to 5 years is all that is really necessary in their area of expertise. Three teachers are interested in a time frame of 5 to 10 years and one teacher in a 10 to 15-year range.

The methods being used allow students to apply knowledge, learn critical thinking, create something useful, and to better judge potentials and risks. One downside teachers encountered is sometimes not considering disruptive events or having to neglect certain aspects to focus on others. Teachers have pointed out that when methods are being used that students do not enjoy or lack background knowledge in, then their level of creativity declines. Methods are being taught so they can be easily remembered and aim to provide students with a deeper understanding of the relevance of thinking about the future as well as with an opportunity to create something of value. Students not only gain experience and people skills but also learn to be creative, solve problems, and research information.

All teachers expressed an interest in wanting to learn more about different methods in order to improve their teaching and methods.

8.3. SDU Main Conclusions on Interviews

The five interviewees – who have between one and 10 years of teaching experience in engineering courses – use (4) or plan to use (1) data about future developments; more concretely, projections about the future. Thus, they all find such data useful for teaching – in their case topics such as climate change, technology markets and diffusion, and hype cycles of emerging technology.

When using such data, the teachers combine mainly two didactical formats: frontal traditional lectures and exercises to involve the students – including lab exercises, flash fiction writing, case studies, assignments, and challenges. Students participate in brainstorming sessions, or they work in small groups or pairs.

The teachers have different motives for focusing on future developments. These include personal interest in the topic, but also the intention to combine specific knowledge and future studies and make it relevant for predicting future events and possibly benefitting different stakeholders.

Four teachers point out that their students react positively, some even enthusiastically. The students understand the importance of what they are being taught and how that might be relevant for them. Four teachers experience barriers related to practical issues like time constraints, different language and levels of previous experience, uneven openness to group work, and ability to independently use the given data. One teacher experiences some students not believing in climate change or that the data presented in class is real.

The teachers rely mainly on traditional lab methods or research of scientific literature, but one uses Flash Fiction story writing. Three teachers use mainly qualitative methods, and the other two use both quantitative and qualitative methods. The process they use encompasses introduction to the topic, having students work in groups and brainstorm, and/or using prompts for students to build up stories or discuss.

Three teachers state that they are not or only partly familiar with the specific methods for teaching future scenarios, but that this would help improve their students' competences, allowing them to have a more holistic view of problems and a broad spectrum of tools they can use to approach those problems. One teacher stresses the importance of teaching students how to make narratives about the future, which might be useful in their future work, e.g., when having to incorporate in projects the perspectives of a user group or the public and thereby put deeper knowledge to the service of such communities and companies in an easy-to-understand way. Four teachers emphasize that different learners have different needs.

The teachers focus on near-present scenarios, but those teaching topics concerning climate change work within a 50-200 years' timeframe. All teachers state a need for different time horizons depending on the subjects they are teaching or the methods they are using. The methods they use are rated as simple, realistic, and starting from actual data. However, the teachers often experience lack of time and that students have different knowledge levels that need to be taken into consideration. But the desire is that students improve their communication skills about the potential future and can realize so far unused opportunities. It is about providing students with the tools they need to produce more "nuanced" views about the future to be more credible and provide more interesting perspectives. The teachers mention that students gain employability, context, and the ability to communicate and spread knowledge about potential futures.

Three of the teachers agree on wanting to incorporate more future scenario development methods in their lessons, e.g., methods that are more engaging for the students.

8.4. UBI Main Conclusions on Interviews

The seven interviewees with 2 to 25 years of teaching experience in the area of management, entrepreneurship, computer science, healthcare sciences independently of its level of knowledge and/or familiarization with the use and/or to make predictions about future scenarios.

The use of future scenarios in the teaching environment is in an embryonary stage or is understudied and underused. All teachers mentioned that they have mainly been looking at the near future in their teaching, ranging from 2 to 5 years. In the context of computer science due to the continuous burst of technological improvements if often to think for a time range from 1 to 5 years.

Data about future scenarios is used mainly in the context of curricular units within the bachelor's degree course. The most common way to deliver future scenarios is in a frontal classroom format as an informational motivator or a curiosity on the subject. In addition, some participants also correlated future scenarios with the industry and the subsequent real-world situations such as the use of VR application, forecasting of the IoT growth, long-term sustainability, just to mention a few.

The discussion promoted into the context of this interview paved the way to motivate participants to promote complementary activities related with group work, workshops and research related with future scenarios and futuristic thinking. In addition, all teachers expressed an interest in wanting to learn more about different methods in order to improve their teaching and methods.

Furthermore, participants also pinpointed that using data about future scenarios may help students in its understanding of lecture contents. In addition, it may empower participants with the knowledge of insight on advancements that topic specific are moving at an accelerated pace. This may help students to improve their motivation and thinking out-of-the-box, and also to realize scenarios of application for different technologies.

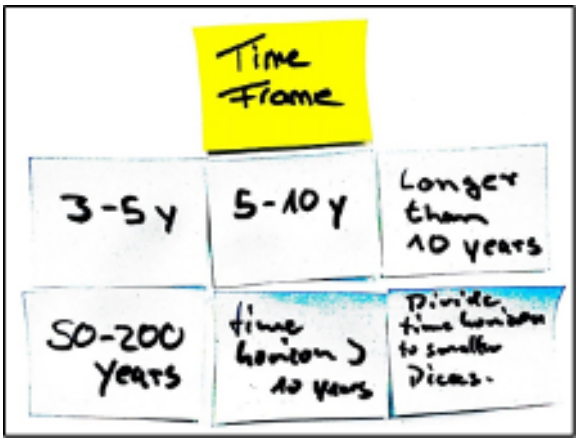
One identified challenge is related with the students' imagination as a main limitation for a fully and immersive experience on future scenarios. On the other hand, instructors may ensure that given scenarios are comprehensible and explainable enough with the related topic(s) along with a realistic interpretation.

8.5. Training Mapping Exercise Results

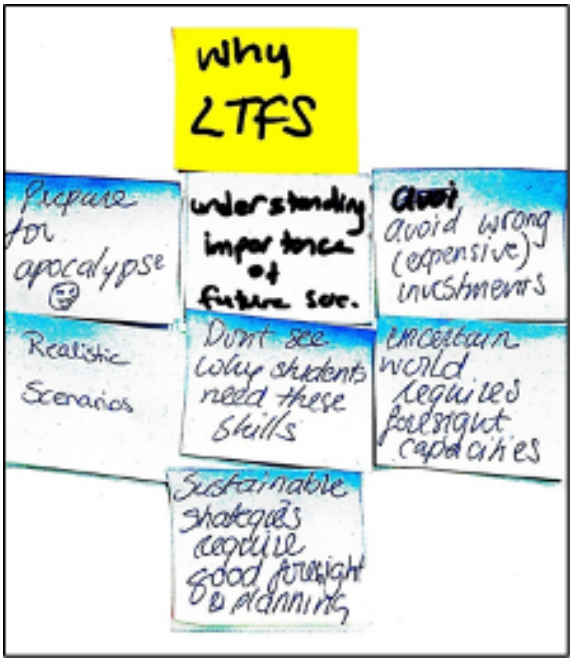
Needs:

Teacher Skills
I don't know what it is or why it is important
how to act teaching online?
Holistic view on problem
ABILITY TO DEFINE AND DESIGN SCENARIOS
reduce time preparing 4 courses
non-english learning material
Different Learner Needs Adaptive
assisting to practical issues
holistic view

Student Skills
enhance ability to think outside the box
need to realize scenarios for different technology applications
realistic interpretation of available ESs
improve student communication skills about
increase student's awareness
preparing students for future scenarios realise unused opportunities
CREATIVE THINKING
PROMOTE STUDENT'S BRAINSTORMING
Enhance competition
Students using understanding
Teach to filter info
Students limited imagination
Strategies from scenarios
Adapt to future situations
Grow the curiosity
realise unused opportunities
TEAM SKILLS TO ADDRESS SCENARIOS


Time Frame
3-5 y
5-10 y
Longer than 10 years
50-200 years
time horizon > 10 years
Divide time horizon to smaller pieces.

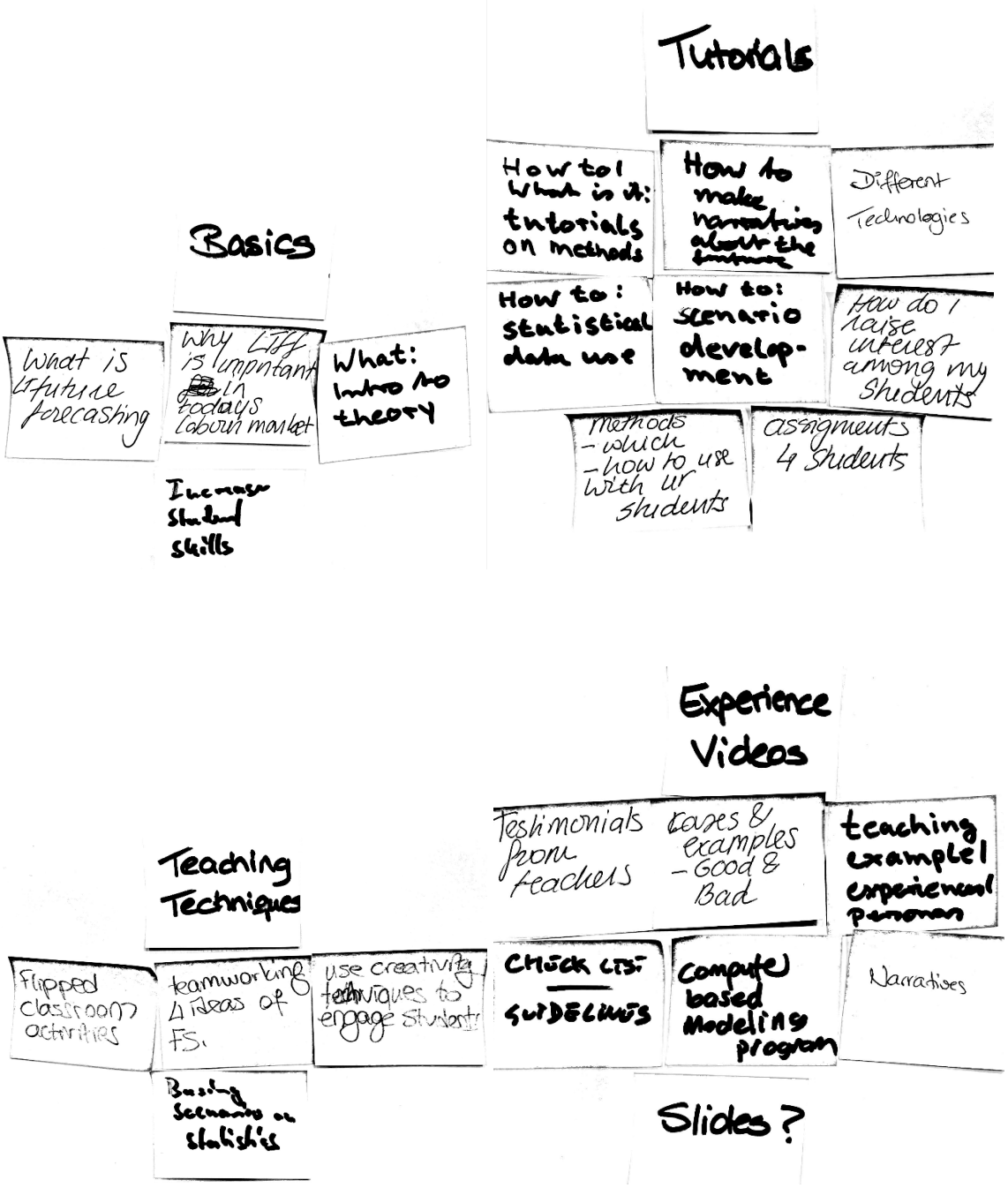
Methods
info on LTFS methods
Know your methods
statistical data use
complementary activities
COMPUTER BASED MODELLING PROGRAMS
More on Methods

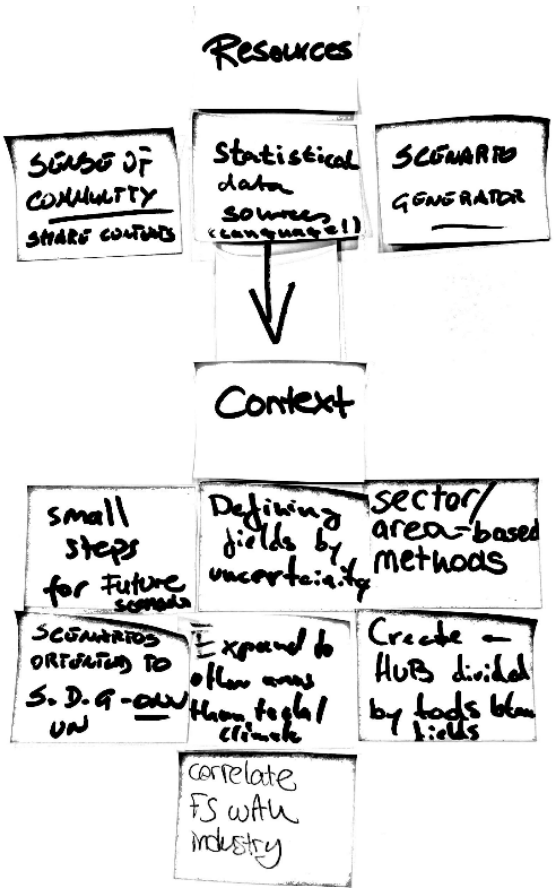

Why LTFS
Prepare for apocalypse
understanding importance of future soc.
Avoid avoid wrong (expensive) investments
Realistic Scenarios
Dont see why students need these skills
uncertain world requires foresight capabilities
Sustainable strategies require good foresight & planning

Pedagogy
pedagogical knowledge
pedagogical knowledge
how to improve student imagination
how to deal with pedagogic challenges
how to improve student motivation
Pedagogical Knowledge regarding methods
CLASS ROOM DYNAMICS

Theory
Theory
Stablish the basics (awareness)
Theoretical knowledge

Ideas:


Tutorials
How to! What is it: tutorials on methods
How to make narratives about the future
Different Technologies
How to: statistical data use
How to: scenario development
How do I raise interest among my students
methods - which - how to use with ur students
assignments 4 students
Basics
What is future forecasting
Why LTFF is important in todays labour market
What: Intro to theory
Increase Student skills
Experience Videos
Testimonials from teachers
cases & examples - Good & Bad
teaching example! experienced personas
Teaching Techniques
Flipped classroom activities
teamworking 4 ideas of FS.
use creativity techniques to engage students
CHECK LTS: GUIDELINES
Computer based Modeling program
Narratives
Basing scenarios on statistics
Slides?


Resources
SENSE OF COMMUNITY
SHARE CONTENTS
Statistical data sources (language!)
SCENARIO GENERATOR
Context
small steps for Future scenarios
Defining fields by uncertainity
sector/ area-based methods
SCENARIOS ORIENTED TO S.D.G - ONU UN
Expand to other areas than tech/ climate
Create a HUB divided by tools btw fields
correlate FS with industry