Environment. Technology. Resources. Rezekne, Latvia
Proceedings of the 14th International Scientific and Practical Conference. Volume 2, 203-208

DIGSM 4.0 Curriculum Lifecycle Based on Component Organised Learning Method

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***Abstract*. The research under consideration is how to build COL (Component Organised Learning) based curriculum lifecycle that teachers can apply in different fields. The problem is that the degree studies curriculum is not always applied to working students as the needs of the companies they work for differ. Companies find it more valuable when students can use the existing curriculum topics to solve today's company problems. Current degree studies take considerable time and are unsuitable for full-time employed specialists. The proposed Education 4.0 concept brings the knowledge and skills required by the market for full-time employed students in a time-efficient way. One possible solution to apply this concept in practice is to create a micro-credential curriculum for companies. The authors suggest using the intensive week approach for analysis, where the students will solve the real company problem using previously studied solutions. They will also use the Moodle courses linked to the developed COL to speed up access to the materials. Authors suggest organising such an event in collaboration with consortium partners and involving all teaching staff who worked on course development. After introducing problems brought by the company and visiting the company on site, asking the questions, students define the task to be solved in groups. After that, the Authors recommend providing intensive courses where each partner will present the developed Moodle materials. The target is that the students will solve the problem in 24h and present solutions to the company representative.**

Keywords: Component Organised Learning (COL), digitalization, Digital Supply Chain, Information and Communication Technologies (ICT), Higher Educational Institutions (HEI).

I. INTRODUCTION

Short-time learning or learning via short courses has become more popular. Higher Educational Institutions (HEI) need to rebuild their curriculums to enable combining work experiences with short-time classes. Current degree studies take considerable time and are unsuitable for full-time employed specialists. The proposed Education 4.0 concept brings the knowledge and skills required by the market for full-time employed students in a time-efficient way. One possible solution to apply this concept in practice is to create a micro-credential curriculum for companies.

A well-structured e-environment for studying is the only way for this. They are building an engaging, time- and skill-consuming curriculum for educators. The authors aim to solve the problem of how to apply COL (component organised learning) modules to full fill students' and enterprises' needs. The challenges to be solved include constructing the education 4.0 concept, shortening the time of bringing enterprise needs to the curriculum and validating the named idea.

Print ISSN 1691-5402
Online ISSN 2256-070X
https://doi.org/10.17770/etr2023vol2.7311

The concept will help students learn study programs in the certificated organisation in a short time and work simultaneously. It will give students a way to learn further in the future when needed as the study program is transformable to another organisation. At the same time, students learn how to find solutions for the company where they work. For enterprises, it will allow sending students to learn the topics needed to solve problems in specific companies. In the future, the concept could be used in advance for all the enterprises in the same field to select topics required to learn. Those topics could be updated and used in one platform.

Current research aims to align the curriculums to fulfil the needs of the companies on their journey to the digitalisation of Supply Chains. The paper will be focused on the following research questions.

- How to assess dynamically and efficiently the digitalisation needs of companies?
- How to create and deliver the required digitalisation knowledge by creating the courses?
- How to validate courses that they full fill all participant's needs?

The Digital Supply Chain Management 4.0 (DIGSCM 4.0) project supports this research. The developed framework is constantly improved by partner organisations from TTK University of Applied Sciences (TTK UAS, Estonia), Rezekne Academy of Technology (RTA, Latvia), and Vytautas Magnus University (VDU, Lithuania). The project's goals are to build the DIGSCM module, which consists of 15 courses targeted to cover the digitalisation needs of the companies. The project is limited to Purchase and Procurement, Logistics and Manufacturing. The authors focus on digitalisation's effects in a supply-chain context.

Today our research group have completed the execution and international validation of 5 courses. Teachers and students have received valuable experience before we further deliver the subsequent ten courses. Implementation of courses took place during the academic year of 2021/2022, and the research group is interested in sharing the current results. We improved the framework suggested in the previous paper [1] by introducing the Component Organized Learning (COL) matrix, which enables us to connect the assessment of skills, technologies, and impact of digitalisation provided by companies from the Procurement, Manufacturing and Logistics sectors. Companies share with universities the current expectations, and universities review and deliver those expectations through DIGSM 4.0 module courses. The target is to enable a dynamic teaching environment and reduce the delivery time of skills to the market by adjusting the courses by using the COL approach, delivery of this knowledge to the contributed companies at the end of the semester by preparing the students for the company annual internships, the readiness of students to contribute to problems solving in final theses and final providing the skilled alumni for businesses.

II. LITERATURE REVIEW

This literature review will present novel perspectives and topics under investigation. The literature review will give an overview of how workforce learning is done at the moment and how curriculum review is changed during the timeframe. Added is what are their limitations and future perspectives. As our work is directed at using micro degrees and learning while working, we will focus on those topics mainly. Although the provided solution is applied in the eLearning environment, its flaws will also be essential to consider. For instance, students could need eLearning challenges for more self-regulated learning and using technology [2]. Challenges could also be lectures' reluctance to deliver content using technology [3]. This problem is decreasing as massive use during the COVID-19.

Learning could happen around the world, and topics are repetitive. To hold reusability higher, the concept of RLO is proposed in literature before [4], [5], [6]. The name and concept are different from those used before RLO (Reusable Learning Objects) [7]. All named research was focused on what criteria and qualities reusable learning objects should have but not used in the context of timeshare between parts of the thing. Our solution takes a view of the internal structure of an object.

There is a way to share learning objects between stakeholders using a digital platform. Integrated E-Learning Objects Design Model and Implementation into Educational Platforms help reduce the time developing instructions and help share knowledge between universities [8]. The weakness of reusable learning instructions is that they could be outdated [9]. Platforms could be underusage as enterprises won't use educational organisation platforms and sheer them between enterprises.

The Industrial Revolution 4.0 brought with it the introduction of new teaching methods. New opportunities have brought people and technology together and created a more flexible environment for learning and studying programs adaptable to enterprises' needs. Peter Fisk defined the main trends related to Education 4.0 [10] as learning can be taken anytime, anywhere. The more personalised practices, the possibility to choose the way You learn, more hands-on learning, applying theoretical knowledge to practical case solving, and considering students' feedback. The research states that the need for learning topics and content should be driven by market force [11]. At the same time, much research has stated that conventional curricula lack the requirements of what the modern job market needs [12], [13], [14]. The importance of changing the curriculum accordingly to the need of today's workforce is also mentioned [15]. Still, this research is losing the timeframe between curriculum redesign and delivered curriculum. In today's world, it is essential to have shortened time cycle for learning as students work.

In [16], curriculum redesign is prolonged and resource-consuming activity. Thus, it is essential to have initiatives that reduce resource consumption in the design curriculum.

III. COMPONENT ORGANISED LEARNING CONCEPT

Authors have reused the previously discussed trends to develop a new learning approach - Component Organised Learning (COL), which uses interactive practical assignments [1]. COL has a common structure that RLO (Reusable Learning Object) lacks and gives a more standardised body to objects, and allows analysing and studying the concept's good sides and flaws. Our solution provides an opportunity to revise the COL annually by analysing answers from companies and changing the content. Advantages COL for students are introduced in Fig.1.

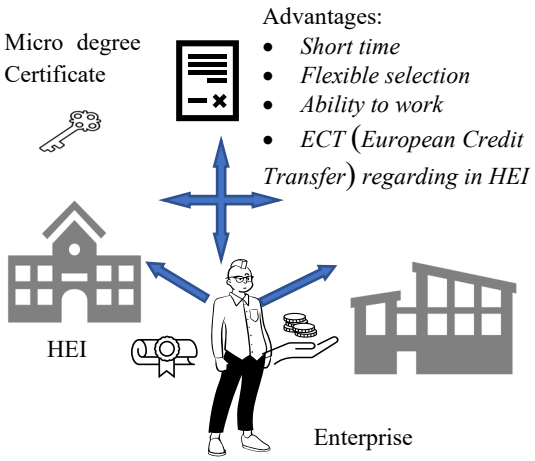

Fig. 1. Student choce.

How it works is shown in the Fig. 2.

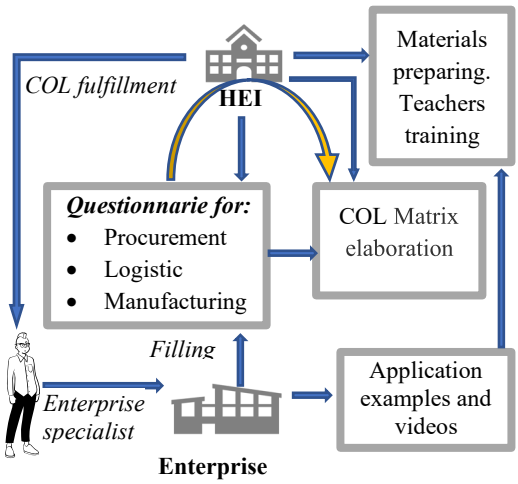

Fig. 2. COL implementation.

Component Organised Learning (COL) is a concept, suggested by authors to divide the course into small cells corresponding specified duration of the learning task [1, 17]. Potential users of the framework would be logistics and management and administration teachers, companies, and students. Once the COL is created and connected to related study outcomes, it can be successfully reused in different e-learning courses to support content flexibility and course connectivity. COL enables the interconnection between different curriculums, which provides a broader view of the value chain essential for students to become better specialists. It also supports the flexibility and optimal use of teaching staff, with the possibility of simultaneous teaching of COL related to different courses and curriculums. In the current research, the authors develop a COL matrix, which defines the relationships between required knowledge, technologies and implementation impact provided by the study outputs of the courses.

The lecturer prepares a questionnaire and introduces it to partner companies interested in university students to design the study block. The questionnaire will enable dynamic adjustment of curriculums towards the expectations of companies in the digitalisation field.

Using the questionnaire, the lecturer assesses the competencies, technologies, expected impact, and challenges companies request, analyses and generates the study outputs into the existing curricula courses. Then, in cooperation with the partner universities, additional study blocks are developed to cover the necessary competencies. The completed modules are offered to students within the existing subjects or electives, focusing on developing critical thinking and reflection skills. After implementing the curriculum, the teacher asked students to fill in a questionnaire to validate the delivery process of the requested skills. [18-20].

A. COL structure

The idea of COL structure, see Fig 3. is suggested by partner universities. Today we combine the video-recorded lecture and practical part performed in selected ICT (Information and Communication Technologies) tools and discuss the sharing of teaching load between HEI-s. Using the ICT tools via hybrid learning and e-learning gives more possibilities for communicative learning for teams with members in different locations.

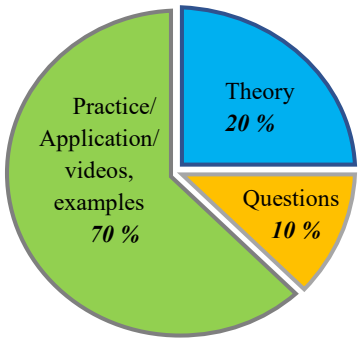

Fig. 3. COL structure.

B. COLs defined on base of questionnaires

The authors have developed and spread the questionnaires to the Baltic States companies in Logistics, Manufacturing and Procurement fields and suggest selecting COL from the list based on previously defined parameters, see Table 1. The definition of technologies aims to support mapping skills required by companies with particular learning content.

TABLE 1 COL NAMES WITH SIMPLIFIED DEFINITIONS

COL	Definition
1. AI	The ability to teach the algorithm based on validated data
2. BIG DATA	Ability to create new knowledge based on a significant amount of data
3. IOT/ Blockchain	Ability to extract the data from devices / secure the operational data
4. BPM	Business Process Mapping software
5. SMART SENSOR	Know-how and skills for the usage of radio frequency identification and smart sensors in tracing of supply chain processes
6. Cyber Security	Cyber security tools and policies
7. Predictive Analytics	Predictive software, forecasting algorithms
8. ERP	Enterprise resource planning
9. Innovation	Ability to create new solutions, previously not used in current context
10.Communication	Communication software, Social Network software, messengers, skype, etc.
11. Robotisation	Able to replace the manual activities by using robot or RPA solution
12. Lean and Agile	Lean and Agile tools and software
13. Risk Management	Ability to estimate the non-fulfilment of strategic targets
14. Cloud	Software working in the Cloud environment
15. SCOR	Supply Chain Operation Reference model-based
16. Integration	Integration between different Information Systems
17. API	API interfaces for data exchange
18. Simulation	Simulation software (processes, games)

The next chapter shows how this list was developed on the Digital Supply Chain Management 4.0 project example.

IV. DIGSCM 4.0 PROJECT

The project's goals are to build the DIGSCM module, which consists of 15 courses targeted to cover the digitalisation needs of the companies. The project is limited to Purchase and Procurement, Logistics and Manufacturing. The authors focus on digitalisation's effects in a supply-chain context.

Curriculum development based on the questionnaire for enterprises enables dynamic adjustment of learning programs towards the expectations of companies. Authors have developed questionnaires for the Baltic States' companies to get their knowledge, impact, challenges and technologies preferences. Primary statistical information about respondents is introduced in Table 2.

TABLE 2 STATISTIC INFORMATION ABOUT RESPONDENTS

Country	Logistics	Manufacturing	Procure-ment	Total companies
Lithuania (*LT)*	15	27	10	52
Latvia (*LV)*	3	11	4	16
Estonia (EE)	7	5	4	16

HEIs map the required knowledge of the companies to a particular topic in the suitable course, select the expected impact and related technologies from the questionnaire, and add them to the matrix. The impact will show how the delivered digitalisation knowledge will support the companies in achieving business targets.

Calculation of the weight of questions based on questionnaire data.

> *Questions weight = (Estonian companies assessment % + Latvian companies assessment % + Lithuanian companies assessment %) /3 /100.*

Calculation of the priority of COL based on weight as:

> *Priority=points of Knowledge required* X *points of impact of digitalisation* X *points of tool importance.*

The size of the COL will be periodically readjusted at the beginning of the academic year to better correspond to the updated needs of the company. The advanced teaching method will also be applied for existing re-educating employees by providing micro degree programs. The student selects the courses aligned with the current employer's strategic directions and plans in Supply Chain Digitalisation.

The size of a particular topic in the course will depend on question weight; for example, the topics that received higher priority will have a more significant amount in ECTS in each course. The advantage of the method is that it increases the motivation of students, partner companies, and teachers by joining contributions and fulfilling requirements.

For example, Table 3 introduces a priority index definition matrix for COL 4, COL 14, and COL18.

TABLE 3. MATRIX FOR COL PRIORITY INDEX DEFINITION

COL	Knowledge required	question weight	Impact of digitalisation	question weight	Tool importance	question weight	Priority index
14. CLOUD COL	Know-how and skills of the usage of procurement platforms based on "many-to-many" communication.	0,76	Transparency and traceability within the supply chain ecosystem will strengthen buyer-supplier relationships	0,5	Procurement platforms based on "many-to-many" communication will simplify my daily business	0,8	0,3
18.Simulation COL	A common user interface (for platforms and applications) will enable me to work more efficient and effective	0,76	Transparency and traceability within the supply chain ecosystem will strengthen buyer-supplier relationships	0,5	Abilities to use common user interface platforms and applications in executing supply chain operations.	0,73	0,3
4. BPM COL	Know-how and skills of the usage of procurement platforms based on "many-to-many" communication.	0,7	Procurement function will be a strategic interface to support organisational efficiency, effectiveness, and profitability	0,66	Procurement platforms based on "many-to-many" communication will simplify my daily business	0,8	0,4

TABLE 4. DSCM COURSES

	DSCM Courses	Planned Course	ECTS
Procurement	Course 1	Purchasing and Procurement Management	3
	Course 2	The organisation of the digital purchase process	3
	Course 3	Introduction to Public Procurement Planning and Procedure	3
	Course 4	Project. Purchasing and procurement organisation	3
	Course 5	Project. Analysis of the procurement process	3
Manufacturing	Course 6	Introduction to Supply Chain digitalisation	3
	Course 7	Intelligent Manufacturing and Industry 4.0 tools	3
	Course 8	Transformative technologies	3
	Course 9	Digital Twin for Manufacturing Environment	3
	Course 10	Manufacturing Process Management in Supply Chain	3
Logistics	Course 11	Logistics 4.0 and Business Process Reengineering	3
	Course 12	ICT in Logistics	3
	Course 13	Transformative technologies	3
	Course 14	Digital Twin for Logistics Environment	3
	Course 15	Logistics Process Management in Supply Chain	3

Based on the priority index was developed 15 courses and defined for them ECTS (European Credit Transfer and Accumulation System) in Procurement, Logistics and Manufacturing areas for Digital Supply Chain Management (see Table 4).

Courses can use one or more COLs. Table 5 shows COL 4, COL 14, and COL18 used in several classes.

TABLE 5. COLS USED IN SEVERAL COURSES

Courses	COL 14	COL 18	COL 4
Course 1	X	X	
Course 6	X	X	X
Course 10		X	
Course 15		X	

V. RESULTS AND DISCUSSION

In the current paper, we introduced the integration of several courses between different HEI-s. At the current stage of the project, the following courses are built/redesigned accordingly to the need of the companies. The new learning methods need to enhance the e-teaching the technical-digital skills combinations. For the best outcome, the data collected from companies via questionnaire defined the competencies, the impact of digitalisation and ICT skills the companies see as the most relevant in supporting their further goals. The introduced approach by mapping created course study outputs with corresponding COL-s and calculating the priority index to define the size of the COL-s. In addition, students' feedback improves the development of the lowing ten courses in the projects.

International teaching experience for TTK, RTA and VDU students and teachers highlighted several challenges to be solved. They applied real-time teaching environments and worked on infrastructure preparation for common near-

life project preparation. The data collected will be described in the ERP system to be fulfilled by the different roles of HEI partners. TTK UAS students will be responsible for Procurement and purchasing components, RTA students will perform the manufacturing activities, and VDU students will perform logistics for materials and finished items. Training in conditions near real life, like using different software solutions, gamification and simulations and enabling students to participate via remote solutions can be one way. Guiding and assessing students' tasks remotely need to develop, considering the student's expectations and employers' needs.

COL question weights may change with the re-study of future employer needs, which will change the priority and the size of corresponding topics in particular courses for the next study period. The designed courses content was adjusted based on company requirements, and the authors plan to use the COL matrix to design the following courses.

VI. CONCLUSIONS

The research paper's authors have developed a framework for dynamic curriculum improvement supported by the DIGSCM 4.0 Erasmus+ project. The project's target is to periodically update the curriculums based on business requirements at the beginning of each study year.

This work authors have designed the questionnaire to evaluate dynamically and efficiently the digitalisation needs of companies. A study of the needs analysis of the business sector was carried out. It helped to highlight the need for the knowledge, competencies and skills of trained specialists in the fields of trade, production and logistics in the 4-industry revolution. During the research, the authors carried out the analyses of competencies, abilities and knowledge needs at the international level and adapted the portfolio of study subjects so that the trained specialist would be suitable not only for companies operating at the national but also at the international level was observed.

ACKNOWLEDGEMENT

This research has been financed by the European Social Fund via the IT Academy programme.

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