

Towards a STEAM model for digital fluency skills: perceptions by students and teachers

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Abstract

Transliteration involves skills, critical thinking and practices based on digital fluency in a changing context. This concept is based on the inquiry process of scientific research, but is currently not integrated into a STEAM approach. In the first phase of the TLIT4U Project, an attempt was made to clarify the STEAM framework towards an inquiry-based training model. The authors belonging to different universities in Bulgaria, Finland and Italy investigated the perception of the concept of digital fluency and the research process awareness of the students of the respective universities, with different disciplinary backgrounds. Subsequently, the authors organized interviews and focus groups with teacher librarians and scholars of the partner universities to investigate their perception of transliteracy. The main findings and open questions highlighted by the TLIT4U comparative study are presented in this paper.

Keywords:

STEAM; Transliteracy; Inquiry based learning; Digital competencies; Digital Fluency

Introduction

The acronym STEAM represents the starting point for a new way of learning and teaching in higher education. In a STEAM approach the S for Science is the starting point and is used to identify and study the research problem, to establish the cause and to show students the solutions adopted so far. The T of Technology represents the set of tools necessary to implement the initial solution to a problem. E of Engineering is the implementation method as the effectiveness of a research design is based on the combination of “user expertise” and “tool complexity”. From the A of Art, the STEAM approach takes creativity, an innovative and disruptive element in the STEAM alphabet. In fact, art serves to broaden horizons and to approach things in a completely different way. The M of Mathematics, in a STEAM activity, remembers that collecting feedback, applying it, modifying the project, returning to the original problem, searching for new questions, trying and trying again, are all important moments as they are representative of the research inquiry and experimentation process. The acronym STEM is often used, because it is not considered Art. UNESCO (2019, p. 11) affirms that:

“STEM competence covers both the ‘know-what’ (the knowledge, attitudes and values associated with the disciplines) and the ‘know-how’ (the skills to apply that knowledge, taking

account of ethical attitudes and values in order to act appropriately and effectively in a given context). In the information age of the 4th Industrial Revolution, the ‘know-what’ and the ‘know-how’ of STEM encompasses the traditional components of knowledge, skills, values and attitudes and the all-important expansion of information, big data and technology”.

This definition highlights that we cannot limit ourselves to interdisciplinary contents but that the research process is as important as the content. So a different way of thinking to solve problems has to be considered. Furthermore, the UNESCO definition highlights that the STEM approach is necessary in the world of work, to make nations competitive in a society that is constantly changing. The STEAM approach that the authors highlight in this article focuses on the integration with transliteracy skills, considered as a continuum of digital fluency skills. Digital fluency is a term which updates different definitions of "literacies" corresponding to different phases of the inquiry process (Fleming et al. 2021). In the context of the TLIT4U Project¹ the authors considered that a STEAM approach, integrated with teaching and learning trans-literacy and digital fluency competencies, now makes it possible to improve the inquiry based learning process and every teacher can offer students equal learning opportunities for acquiring the digital fluency competencies.

A problem of the STEAM approach is that some teachers focus on technology as a new set of digital skills to be developed separately from the curriculum content, and not integrated into each subject research method (Livingstone 2012). This is the reason why it is important to understand teachers' beliefs and perceptions related to STEAM. Teachers, as important people in a student's skill acquisition, have prior experiences that will influence their STEAM education and learning.

¹ TLIT4U - Improving Transliteracy Skills through Serious Games is an Erasmus + Project number 2021-1-BG01-KA220-HED-000027624. The TLIT4U Erasmus + project has been implemented since 2021 by three European higher educational institutions . The acronym TLIT4U stands for “Improving Transliteracy Skills through Serious Games” and highlights the need to improve students' multiple literacy skills and teachers learning in STEAM using serious games. The TLIT4U Project aims to cultivate and upgrade a broad range of literacies, called trans-literacy and identifies STEAM education to engage students with inquiry based learning using a serious games approach. More information: <https://translit-eu.unibit.bg>

The aim and objectives of the research were to explore the perception of the problem of students and teachers and to understand the context of the three different partner universities of the TLIT4U Project: University of Library Studies and Information Technology - ULSIT (Bulgaria), University of Parma (Italy), University of Lapland (Finland)) and one non-governmental organization Fondazione Politecnico di Milano - FPM (Italy)

The following objectives were expected:

- exploring the student's awareness of digital fluency terms;
- assessing the students level of skills according to the EU DigComp 2.0;
- studying the "experts" groups' perception and their attitude to the application of STEAM approach in their teaching.

Literature review

Enrolments in STEAM disciplines at universities are increasing globally, attributed to the greater life opportunities open to students as a result of a STEAM education. But while institutional access to STEAM programmes is widening, the retention and success of STEAM undergraduate students remains a challenge. Pedagogies that support student success are well known; what we know less about is how university teachers acquire pedagogical competence (Winberg et.al, 2019). Calls to improve student learning and increase the number of science, technology, engineering, and math (STEM) college and university graduates assert the need for widespread adoption of evidence-based instructional practices in undergraduate STEAM courses. Faculty identify a variety of barriers to proposed changes in teaching practice; however, faculty also identify a variety of drivers that might help the institution to change teaching and learning norms (Shadle, Marker & Earl, 2017).

The EU STEAM Coalition² is a European network working to build better STEAM (science, technology, engineering, art, mathematics) education in Europe. The main goal of STEAM methods is to activate a consistent process of inquiry based learning, with a focus not only on the competencies, but rather for the process itself. The way in which the inquiry is realized is much more important than the result. The teacher's role is to monitor and assist in the various stages of task performance. Wherever and whenever necessary, he/she intervenes and supports the inquiry process. Students' assessment is made taking into account the complex performance of the inquiry.

² <https://www.stemcoalition.eu/about>

The inquiry process not only characterizes STEAM education but also the Media and Information Literacy approach. From a policy point of view, the book “Media and information literacy: policy and strategy guidelines” published by UNESCO in 2013, constitutes a sort of manifesto of the UNESCO vision on Media and information literacy (MIL) (UNESCO, 2013). The text begins by explaining the relevance of MIL Policy and Strategy in the digital age and continues by illustrating how MIL is a composite concept. Designed in 2019 and launched in 2021, the Global Standards for MIL Curricula Development Guidelines form a relevant basis to guide media and information literacy curricula development and implementation by stakeholders in countries around the world. Media and Information Literacy (MIL) is a basis for enhancing access to information and knowledge, freedom of expression, and quality education. It describes skills, and attitudes that are needed to value the functions of media and other information providers, including those on the Internet, in societies and to find, evaluate and produce information and media content; in other words, it covers the competencies that are vital for people to be effectively engaged in all aspects of development.

In partial overlap with MIL, the concept of transliteracy highlights the many literacies that today make the inquiry process complicated (Ipri 2010). The word “Transliteracy” has been originally defined by Thomas, Joseph, Laccetti, Mason, Mills, Perril and Pullinger (2007) as:

"the ability to read, write and interact across a range of platforms, tools and media, from signature to oral through handwriting, print, TV, radio and film, to digital social networks "

Sukovic (2017) later defines transliteracy as a “fluidity” of movement across a range of technologies, media and contexts:

“Transliteracy is an ability to use diverse analogue and digital technologies, techniques, modes and protocols:

- *to search for and work with a variety of resources*
- *to collaborate and participate in social networks*
- *to communicate meanings and new knowledge by using different tones, genres, modalities and media”.*

The concept of transliteracy is combined with the concept of fluency. Digital fluency is a relatively new term. Unlike Digital Literacy, which means understanding how to use technology and different tools, Digital Fluency is the ability to create something new with them (new information, a new product). Transliteracy consists of skills, knowledge, thinking and acting, which enable a “fluid” movement across’ in a way that is defined by situational, social, cultural and technological contexts including capabilities such as:

- Find
- Evaluate Select
- Manage
- Create
- Reflect

Bruce et al. (2012) have developed similar concepts and argue that “experiences of informed learning” (p. 527) include: information awareness, sources, process, control, knowledge construction, knowledge extension and wisdom.

The interconnection between multiple literacies and STEAM education is found in the inquiry process. The two most important frameworks on INQUIRY Models include: FOSIL, or Framework Of Skills for Inquiry Learning and Carol Kuhlthau GID - Guided Inquiry Design.

FOSIL³ is a model of the inquiry process including Connect to previous knowledge, Develop questions, Investigate, Construct, Express, Reflect. Inquiry is an approach to learning (not limited to information skills) and the model has been developed by Barbara Stripling. These tools help educators to design and resource effective inquiries – often as a collaborative team involving teachers and librarians – and to support students engaged in inquiry. FOSIL is based on ESIFIC, a continuum of skills and strategies includes new focus on:

- multiple literacies, including visual and media literacy
- use of technology for learning, including digital literacy skills pre-kindergarten
- personalization of learning

³ <https://blogs.slj.com/neverendingsearch/2019/08/10/the-newly-reimagined-empire-state-information-fluency-continuum/> <https://fossil.org.uk/fossil-cycle/>

- evaluation of multiple perspectives
- digital citizenship and civic responsibility
- design thinking, including innovation and creation
- student voice and agency

Guided Inquiry Design (GID)⁴ is a research-based pedagogical framework developed by Carol Kuhlthau for teaching information literacy skills. The inquiry framework for designing and facilitating inquiry based learning include: Open, Immerse, Explore, Identify, Gather, Share, Create, Evaluate.

Theoretical framework

The theoretical framework guides the research of the project and determines how the project can compare the different contexts of the partners: Bulgaria, Finland, Italy. From the analysis of the literature, a general representation of the relationship between concepts has been extracted. The framework focuses on existing and time-tested theories and definitions of transliteracy and includes the state of the art and the results of various researches. We have in TLIT4U three contexts: technological, pedagogical, cognitive background and the demands of different academic disciplines including Library Information Science (LIS). Trying to put together the definition and competences in the literature, the following matrix (Table 1 Digital fluency (Transliteracy) continuum) can be used for defining the theoretical framework for the TLIT4U Project. The theoretical framework lists the different elements in the concepts of information, digital literacy and digital fluency. In particular the “fluency” definition continuum is described in Table 1 as follows:

Table 1 Digital fluency (Transliteracy) continuum

Competencies	Definition
ACCESS (Information Data literacy)	Ability to identify information resources and find them
INNOVATION (Communicate Collaborate Create)	Ability to communicate, collaborate and create content using technologies

⁴ <https://guidedinquirydesign.com/gid-articles/>

TECHNOLOGY (Manage technology Safety)	Ability to use technologies and be aware of cyber security
COGNITIVE (Problem solving Critical thinking Citizenship)	Critical thinking skills, critical analysis, even active citizenship
LEARN (Learning Teaching Reflecting)	Ability to learning and teaching using technologies, reflective practice
CONNECT	Ability to understand in depth the resources identified and used, build new knowledge by connecting concepts

Methodology

The current research examined students from three universities - University of Library Studies and Information Technologies - ULSIT (Sofia, Bulgaria), University of Parma (Parma, Italy) and University of Lapland (Rovaniemi, Finland) and university lecturers, teachers, library specialists (called experts) of the three partner university and the Milan Polytechnic Foundation.

The methodology for selecting the sample of students included sending invitations to students from the three universities, with the intention to reach at least 80 respondents. The same method of invitation using the email list of the three partners was applied to the second group of “experts”, reaching up to 20 respondents.

The following research tools were used to collect data:

1. online questionnaire to students translated into the three partner languages
- and 2. structured interviews to “experts” also translated into the three partner languages.

Target group-students

To investigate the students' perceptions, the project team organized a “Digital Fluency Workshop” with the aim of introducing the concepts of transliteracy, STEAM and Digital fluency to students. Professor Miltenoff Plamen was the expert speaker who illustrated the various topics, segmented in 9 micro-questionnaires for each of the topics covered.

The Workshop in Sofia was held in presence in March 2022. The Digital Fluency Workshop with the Finnish students and Italian students was held online in April 2022.

The questionnaire (Annex 1) is divided into three parts. The first part aims to understand the degree of awareness of key terms such as Digital fluency, Media and information literacy, Soft skills, Tech skills, etc. and the level of expertise for the research process. The second part is self-assessment of the skills acquired according to the European DigComp 2.0 framework in five blocks: Information and data literacy, Communication and collaboration, Digital content creation, Security, Problem solving. The third part of the questionnaire is aimed at exploring the attitude and awareness of the target groups towards terms such as Education 4.0, Industry 4.0, Internet of Things (IoT), Big Data, Artificial Intelligence (AI),

Digital Humanities (DH): these terms are part of everyone's daily routine and are a prerequisite for innovations in all areas of life.. Many of the questions are closed-ended but the question on the level of expertise on 21st century research skills is open-ended.

The Bulgarian students who answered the questions were 62 (but participants in Workshop 101) of which the majority (33%) aged 37-47 and immediately after (27%) young people aged 26-36. In Finland, 57 students were investigated, the majority (63%) of whom were 21-25 year olds and immediately after (21%) even younger 18-20 year olds. In Italy, 21 students answered the questions (while there were 37 participants in the Workshop) with the majority of those interviewed (50%) in an age range between 21-25 and immediately after (20%) young people between 26- 36 years old.

The processing of information has been carried out through statistical data processing programs, and open questions have been coded and processed manually.

Target group - librarians, teachers, lecturers

To investigate teachers, the authors organized a session of interviews and Focus Groups with a sample of experts. The interviews and focus group used the same structure of the 9 questions of the TLIT4U Project (see in Appendix 2). The responses collected during the Focus Group were transcribed semi-automatically (using Youtube subtitles), trying to report the whole discussion

The respondents' opinions were highlighted about: What do teachers and instructors think of digital literacy? What do they think of digital fluency? In particular, what do librarians-instructors, teachers of the humanities and engineering areas think? Finally, what do they generally think about the use of technologies to teach and learn?

The answers were transcribed and coded. To encode the responses they were analyzed using the theoretical framework developed by the literature review.

Student's perceptions

All respondents in the three countries share a positive approach towards innovation and the use of technologies for scientific research and wish to improve their digital fluency. There are differences in perception however, as does the understanding of the scientific inquiry process and also the priorities of digital fluency capabilities.

Research Continuum

In Bulgaria the students' idea of what scientific research and skills are in the digital world are recognized as 'a rather important aspect in people's lives today'. Media and information literacy in modern times is considered extremely insufficient to be adequate and competitive in the labor market. In most of the judgments expressed, students would like practical training and skills in using technical tools. However, the understanding of the complexity of the investigation process is evident: "collection of different data on the object of the research", "facts and new knowledge or their collection and systematic analysis", "search, analysis and verification of data ". Some respondents use general formulations to express their thoughts on 21st century research: "the application of scientific methods to the study of something", "process" and the like.

Since development and progress are defined and guided by the scientific approach of science and scientists, the students were asked on their vision of scientific research. Media literacy is an important topic in Finnish curricula, starting from early childhood education up to higher

education. The terms used in teacher training are media literacy/media education and multiliteracy, which may have confused respondents, but otherwise the answers on digital fluency and awareness are perfectly in line with their previous knowledge.

Respondents however forget out-of-process research methods quite often. Interestingly, some respondents also mentioned “sharing” research results and data as part of the research process, even though this is not specifically highlighted in their curriculum.

Finnish students understand digital literacy as the ability and skills to search for, critically evaluate and analyze information, to use various digital tools and work in a digital environment. They motivate their answers as follow: "digital reading skills are about understanding credible and non-credible information and the ability to differentiate", "being able to read, perceive and analyze digital text, image, voice and sound", "using digital tools, platforms and materials to create new things", 'a capacity to critically interpret texts in a digital environment'.

The Finnish students understand the research process as an activity involving several stages, among which: choosing a topic, formulating research questions, searching for information and its critical analysis, combining information, conducting research using certain research methods and formulating conclusions and/or recommendations, guidelines. Interestingly, some of the respondents mentioned that sharing research results is an invariable part of the research process: “ I see the process as follows: extracting information, analyzing information, creating new information and sharing new information" or "we ask research questions, determine methods for extracting information, analyze the information obtained using a certain method, formulate conclusions and evaluate the research process Finally, we publish the results“. There are other interesting opinions expressed by the Finnish students: “the research process is about determining what we want to know and understand, how we will acquire the information we need, and what methods are best for the purpose. Also, an important aspect is how many people/researchers work on the same problem, as they generate more ideas and opinions and allow the issue to be considered from all sides”; "the process of research involves the study of a certain phenomenon in order to find new information about it. Research is a multidimensional process through which new information is created“.

The majority of Italian students perceived the need for skills for the 21st century mainly technological, there is no agreement on soft skills but many think they need social skills. Digital literacy is intended by some respondents as the capability to evaluate information. Substantial agreement on digital fluency definition: technological skills are especially appreciated together

with communication skills. Fluency is perceived as curiosity, communication, creativity, innovation: every element of digital fluency is appreciated. Ability to analyze data and know how to communicate are the areas of greater impact. Students are demonstrating interest in STEAM education, but the digital transformation of higher education is unknown. Ability to analyze data and knowing how to communicate are considered the areas of greatest impact. It is very interesting that most of those interviewed when asked about the inquiry process mean the search for information, not the methods of academic research.

Table 2 Research continuum

Transliteracy	Bulgaria	Finland	Italy
Digital fluency	In the majority of the opinions expressed, fluency is understood as “computer literacy“, “ability to work with a computer“, “knowledge of the IT sphere“, “being aware of the Internet of Things“, “ability to use ICT“	Fluency is understood as the ability and skills to search for, critically evaluate and analyze information, to use various digital tools and work in a digital environment.	Substantial agreement on digital fluency as technological skills. Soft skills are especially appreciated together with social communication skills.
Research inquiry	Respondents focus on resources and tools for discovering information and knowledge	Respondents understood the process of research as a process, which includes several stages. Respondents forget quite often the research methods out of the process.	Most of the respondents mean inquiry based research, a search for looking for information, analyzing it and using consistently but not the methods of academic research.

Self assessment

In Bulgaria, most students self-assess themselves in a positive way, marking that they have a “good” or “average” level of fluency. However, caution, in our opinion, should be paid to those who answered “average fluency”, as this is the neutral response position where one cannot assess how well they are able to cope with the challenges. The European Digital Competence

Framework also defines skills related to solving problems of a technical nature, as well as the creative use of technology to create and communicate new knowledge (Martzoukou 2020).

Most respondents in Finland evaluated that they are quite or extremely competent in browsing, searching and filtering data, information and digital content. In evaluating data, information and digital content they also replied that they were only somehow competent. Almost as many respondents replied that they were quite or somehow competent in managing data, information and digital content but some respondents said they had poor skills in data management. Respondents evaluated that they were quite good in communicating and sharing through digital technologies but most respondents found that in engaging in citizenship through digital technologies they were only somehow competent. Self-assessment questionnaires reveal some important gaps in Finnish student education.

In Italy most of the respondents are confident in knowing how to find and manage information and data together with the ability to communicate online and create new content is widespread together with security, but they feel they lack programming and copyright skills. Not everyone is confident that they are capable of reusing information.

Table 3 Self assessment

Self assessment	Bulgaria	Finland	Italy
Information and Data literacy	Students feel most comfortable in retrieving information and recognizing the need for it but less confident in their abilities to evaluate information and to manage it. Majority of respondents lack coding skills and have an “average” level of fluency.	Ability to search for, critically evaluate and analyze information, to use various digital tools and work in a digital environment. In copyright and license issues, and especially in coding and programming, students were not very confident.	Students know how to find and manage information and data, to communicate online and create new content. They are capable of reusing information but lack programming and copyright skills.
Communication and collaboration			
Digital content creation			
Safety			
Problem solving			

Experts perceptions

Experts from the three countries were asked about the importance of digital fluency in the field of education and scientific research. To collect data from experts (teachers, instructor librarians, researchers) a structured interview was used with nine questions (Appendix 2) on the perception of the interviewed experts about their attitude and the place of next generation technologies in their teaching.

In Bulgaria, 18 independent in-depth interviews were conducted⁵. This made it possible to reveal essential details and nuances related to the purpose of the conducted research, to search for the root of the problems recorded and possible ways to solve them. The individual interviews with the invited specialists (teachers, university professors, librarians, professionals from the Ministry of Education and Science) took place both in presence and online (connection via videoconference) in the period March-May 2022.

In Finland, four focus groups were organized between 6 April 2022 and 26 April 2022⁶. Participants were librarians (one group with 3 participants), university teachers (2 groups with 4 + 4 participants) and teachers and media education experts (one group with 4 participants). A total of 15 people were interviewed.

The interviews used the 9-question structure of the TLIT4U Project. Only the order of the questions has been slightly changed. The interviews were conducted in Finnish and the results were summarized in English. Three interviews were set up online with Teams, and one interview was a face-to-face meeting. All interviews were recorded and lasted from 55 minutes to 1 hour and 5 minutes.

In Italy, the Focus Group was organized virtually on 14 June 2022 for one hour and half⁷. The target of the interviewees includes various actors: librarians (2), engineering teachers (2), humanities teachers (3) for a total of 7 interviewees, all staff belonging at the universities of Parma and the Politecnico di Milano with an interest in innovation of higher education. The answers collected during the Focus Group were semi-automatically transcribed (using Youtube subtitles), trying to report the entire discussion

The main conclusion for the interviews in Bulgaria was the need for a comprehensive and unified policy of integrating and linking information and digital skills, practically everything

⁵ The moderator of the interviews with the Bulgarian experts was Marcela Borisova, professor at the ULSIT.

⁶ The interviews were facilitated by Mari Maasilta

⁷ The conversations were collected and transcribed by Lucia Coletti. Anna Maria Tammaro and Giulia Conti facilitated the discussion.

that is contained in the perception of the term "transliteracy", to the curricula studied in schools and in universities, including approaches to using technology for creating and communicating new content. Experts point out that this need is important for all participants in the educational process (students and educators), since only people who are confident in their inquiry skills find their successful path to realization and strive for self-improvement. Experts from Bulgaria see the relationship between the concepts of "information and digital literacy", education and libraries most often in the following way: "in the library, education and both types of literacy meet". According to them, information literacy needs to continue to be part of curricula and training, because "it is the basis of digital literacy - the ability to master ideas, to discuss problems, to create", as in the curricula of school and at the university level, it is even necessary to invest much more seriously and comprehensively in information and digital literacy training, which will help "people find a path to realization and improvement with ease and confidence". According to the respondents, the libraries of the educational institutions (higher education institutions, and increasingly school libraries) conduct targeted training for students in information and digital literacy, but unfortunately in Bulgaria they are not particularly popular, probably due to insufficient understanding of their importance. Bulgarian experts believe that training in both schools and universities is still not encouraging and extensive enough in terms of gaining confidence in using technology and different tools to create a new product. Libraries and universities need to create an environment for the development of digital literacy and digital confidence, proposing that this is done by carrying out research on the need for training for the development of digital literacy and digital fluency and creating individualized curricula and syllabi according to the level of development of students' digital literacy.

This opinion is also shared by Finnish experts, who think that students are expected to be able to search, analyze and interpret information, as well as communicate using various digital tools. They should be able to use different digital tools and to create new knowledge in their own research (Bachelor's and Master's theses) knowing the principles of ethical use of information. Multiliteracies and media literacy are important terms in Finnish primary education curricula and university lecturers are expected to be aware of them. As a problem, experts highlight the fact that not all trainers have the necessary skills to integrate the concepts of multi- and media literacy in teaching. The concept of digital fluency is not implemented in the Finnish education system. The term multiliteracies is taken as the basis for the curricula.

In Finland, digital technologies are part of everyday life: work, teaching, learning and research. According to Finnish experts, teachers, students and librarians should know and be able to use

the available tools. They also emphasize that digital technologies promote accessibility for people with disabilities. As a challenge, they see not only the learning of new technologies, but also the selection of the right and appropriate new technologies and tools.

The reasoned opinions of the Bulgarian experts support what was shared by the Finnish and Italian specialists, but also touch on several other aspects: in education, technologies provide an opportunity to present the material in an interesting, fascinating and memorable way to the learners. According to them, the realization of the idea of knowledge-based economy (and in particular lifelong learning) is unthinkable without technologies in the fields of education and scientific research, adding that innovations in science could not be carried out without the use of modern information and communication technologies.

Italian respondents add that technology changes the way of teaching, stimulates curiosity, participation and active learning, but it is also important that trainers (teachers, lecturers, librarians, etc.) know the appropriate tools.

Regarding the relationship between the concepts of information and digital literacy, education and librarianship, experts from Italy share the opinion that learners must have the skills to identify, use and evaluate information resources, in addition to their need to communicate and create new resources using appropriate technologies. Also, they should possess capabilities of independent work and critical thinking. When asked how they see the role of libraries/schools and universities in the formation of Digital Confidence among students, experts from Italy believe that the creation of original content is not limited only to knowledge of technology. According to them, it is necessary to emphasize the purpose and subject of the study/ research, and not only to master the appropriate technology for creating content. In Italy, digital fluency must be understood correctly: it cannot be confused with knowing how to apply technologies, instead it is necessary to know and be able to apply the inquiry process starting from clear objectives and research questions. An important element of digital fluency is the curiosity that must be stimulated by teachers. The teachers themselves must learn new skills, in particular they must know the technologies useful for teaching. As regards the priority of the necessary skills, it must be recognized that Italian students already arrive with a wealth of knowledge and skills deriving from previous learning and from the family context: the problem is that they lack critical skills and analytical skills.

New technologies are the driving factor for the development of innovations in all spheres of everyday and professional life. They require the continuous acquisition of new skills to be applied at a theoretical and practical level. Our active participation in lifelong learning processes is the only guarantee that we will continue to be adaptable and competitive in the face of constant change.

Conclusions

The TLIT4U project aims at introducing innovative practices in the field of higher education through the application of game-based approach for teaching transliteracy and adapting the STEAM model. University educators lack a consistent understanding of STEAM education. Therefore they need to innovate their teaching using the framework of STEAM education. The process of integrating science, technology, engineering, art and mathematics into the academic subject can be as complex as the global challenges that require a new generation of STEAM experts. Educational researchers indicate that teachers struggle to make connections between STEAM disciplines.

Based on the findings of the survey, the TLIT4U project team will design a draft conceptual framework on which to focus the game approach

The conceptual model is based on an adapted STEAM model for inquiry based learning after in-depth analysis of the different perceptions and training approaches related to transliteracy and STEAM in Bulgaria, Finland and Italy. As an end result of the activities on the first project output, the results of the student and expert surveys are used to develop an innovative game for teaching inquiry based learning in higher education, also applicable in non-formal educational institutions, such as libraries. The game could be also adapted to the needs of other target groups of the project - e.g. the informal learning for adults.

If we want the current and the future students to confidently cope with the new biggest challenges in the world, it is necessary to change the way of teaching and acquiring knowledge and skills towards values and attitudes. For this purpose, it is necessary to move from teaching limited to memorizing and reproducing information, towards the use of interactive methods, engaging the participants in the educational process, personalization of the learning content

and orientation to results. The need for teachers and educators to be creative, innovative and inspiring is becoming increasingly clear.

The direct link of serious gaming towards advancing digital fluency and trans-literacy in various higher education curricula could motivate young people and engage them to seek for new knowledge to apply an inquiry based learning approach in their research and creative interests.

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Appendix 1

Questions for students

DIGITAL FLUENCY SURVEY

1. Digital fluency includes the following skills (see the links for examples):

	<i>Strongly disagree</i>				<i>Strongly agree</i>
	1				5
Ability to create content	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ability to evaluate information	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ability to devise reasonable judgments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ability to work with different technologies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2. Digital fluency includes the following skills:

	<i>Strongly disagree</i>				<i>Strongly agree</i>
	1				5
Ability to acquire, assess, and apply technological skills (digital literacy)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ability for teach work and effective communication (social competence)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3. Media and information literacy encompasses the following abilities:

	<i>Strongly disagree</i>				<i>Strongly agree</i>
	1				5
Ability to acquire, analyze, assess, and create content in various forms and formats (text, images, audio and video)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ability to search and find, analyze and apply vetted information	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Ability to form personal opinion and embed information in one's personal knowledge system

The level of Media and Information Literacy's skills is the foundation of active citizenship

4. In one short paragraph, please share your understanding of “digital literacy”.

5. Soft skills are:

	<i>Strongly disagree</i>				<i>Strongly agree</i>
	1				5
Lower level tech skills	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Old type of skills not used by librarians anymore	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Social skills	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6. Tech skills are:

- Technical skills revolve around your professional knowledge and abilities which are specific to your industry
- Only the ability to program and code perfectly
- Proficiency in the latest technologies only

7. Soft skills vs tech skills:

- Tech skills are more important than soft skills
- Tech skills are sufficient to succeed in the 21st century
- Soft skills are equally important to tech skills to become successful information specialist

8. Which of the following belong to soft skills (check as many boxes, as you see fit):

- Good coaching
- Good communication
- Insightfulness
- Critical thinking
- Equality
- Curiosity toward the ideas of teammates
- Empathy
- Emotional intelligence

9. Which of the 7 elements of digital literacy sounds most:

	Appealing to you	Challenging for you
Media literacy	<input type="checkbox"/>	<input type="checkbox"/>
Information literacy	<input type="checkbox"/>	<input type="checkbox"/>
ICT literacy	<input type="checkbox"/>	<input type="checkbox"/>
Digital scholarship	<input type="checkbox"/>	<input type="checkbox"/>
Learning skills	<input type="checkbox"/>	<input type="checkbox"/>
Communications and collaboration	<input type="checkbox"/>	<input type="checkbox"/>
Career and identity management	<input type="checkbox"/>	<input type="checkbox"/>

10. The areas of digital fluency are:

	<i>Strongly disagree</i>	<i>Strongly agree</i>
	1	5
Curiosity fluency	<input type="checkbox"/>	<input type="checkbox"/>
Communication fluency	<input type="checkbox"/>	<input type="checkbox"/>
Creation fluency	<input type="checkbox"/>	<input type="checkbox"/>
Data fluency	<input type="checkbox"/>	<input type="checkbox"/>
Innovation fluency	<input type="checkbox"/>	<input type="checkbox"/>

11. In one short paragraph, pls share your understanding of the process of “research”.

12. Digital Humanities (DH) is an area of scholarly activity at the intersection of computing or digital technologies and the disciplines of the humanities.

- True
- False

13. In one short paragraph, pls share your understanding “Education 4.0”.

14. In one short paragraph, pls share your understanding of “Industry 4.0”.

15. In one short paragraph, pls share your understanding of Artificial Intelligence (AI).

16. Big Data is data that contains greater variety, arriving in increasing volumes and with more velocity.

- True
- False

17. The Internet of Things (IoT) describes the network of physical objects—“things”—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.

- True
- False

18. Which of the following technologies are considered part of immersive technologies:

	True	False
Virtual reality	<input type="checkbox"/>	<input type="checkbox"/>
Mixed reality	<input type="checkbox"/>	<input type="checkbox"/>
Augmented reality	<input type="checkbox"/>	<input type="checkbox"/>
Consensus reality	<input type="checkbox"/>	<input type="checkbox"/>

Reality television	<input type="checkbox"/>	<input type="checkbox"/>
Hyperreality	<input type="checkbox"/>	<input type="checkbox"/>

Section Digital Competences Self-evaluation

1. Information and data literacy. Competences pertinent in this area are:

1.1 Browsing, searching and filtering data, information and digital content

Your ability to articulate information needs, to search for data, information, and content in digital environments; to access them and to navigate among them. Your ability to create and update personal search strategies.

1.2 Evaluating data, information and digital content

Your ability to analyse, compare and critically evaluate the credibility and reliability of sources of data, information and digital content; to analyze, interpret and critically evaluate data and information and digital content.

1.3 Managing data, information and digital content

Your ability to organize, and store information and content in digital environments and retrieve data. Your ability to organize and process them in a structured environment.

19. How fluent are you in information and data literacy? Choose your level of proficiency for each competence.

	Not at all confident				Extremely confident
	1				5
Browsing, searching and filtering data, information and digital content	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Evaluating data, information and digital content	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Managing data, information and digital content	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Section | Digital Competences Self-evaluation

2. Communication and collaboration. Competences pertinent to this area are:

2.1 Interacting through digital technologies

Your ability to interact through a variety of digital technologies and to understand appropriate digital communication means for a given context.

2.2 Sharing through digital technologies

Your ability to share data, information and digital content with others through available (how would the interview know what is “appropriate” digital technologies. Your ability to act as an intermediary, to know about referencing and attribution practices.

2.3 Engaging in citizenship through digital technologies

Your ability to participate meaningfully and responsibly in society through the use of public and private digital services. Your ability to seek opportunities for self-empowerment and for participatory citizenship through appropriate digital technologies.

2.4 Collaborating through digital technologies

Your ability to use digital tools and technologies for collaborative processes, and for co-construction and co-creation of resources and knowledge.

2.5 Netiquette

Your ability to be aware of behavioural norms and know-how while using digital technologies and interacting in digital environments. To adapt communication strategies to the specific audience and to be aware of cultural and generational diversity in digital environments.

2.6 Managing digital identity

Your ability to create and manage one or multiple digital identities and protect one's own reputation. Your ability to handle the data generated through several digital tools, environments and services.

20. How well do you communicate and collaborate? Choose your level of proficiency for each competence.

	Not at all confident				Extremely confident
	1				5
Interacting through digital technologies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sharing through digital technologies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Engaging in citizenship through digital technologies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Collaborating through digital technologies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Netiquette	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Managing digital identity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Section | Digital Competences Self-evaluation

3. Digital content creation. Competences pertinent to this area are:

3.1 Developing digital content

Your ability to create and edit digital content in different formats, to express oneself through digital means.

3.2 Integrating and re-elaborating digital content

Your ability to modify, refine, improve and integrate information and content into an existing body of knowledge to create new, original and relevant content and knowledge.

3.3 Copyright and licences

Your ability to understand the application of copyright and licenses to data, information and digital content.

3.4 Coding and Programming

Your ability to plan and develop a sequence of understandable instructions for a computing system to solve a given problem or perform a specific task.

21. How fluent are you in digital content creation? Choose your level of proficiency for each competence.

	Not at all confident				Extremely confident
	1				5
Developing digital content	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Integrating and re-elaborating digital content	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Copyright and licences	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Programming	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Section | Digital Competences Self-evaluation

4. Safety. Competences pertinent to this area are:

4.1 Protecting devices

Your ability to protect devices and digital content, and to understand risks and threats in digital environments. To know about safety and security measures and to have due regard to reliability and privacy.

4.2 Protecting personal data and privacy

Your ability to protect personal data and privacy in digital environments. Your ability to understand, use and share personally identifiable information while being able to protect oneself and others from damages. Your ability to understand that digital services use a “Privacy policy” to inform how personal data is used.

4.3 Protecting health and well-being

To be able to avoid health-risks and threats to physical and psychological well-being while using digital technologies. To be able to protect oneself and others from possible dangers in digital environments (e.g. cyber bullying). To be aware of digital technologies for social well-being and social inclusion.

4.4 Protecting the environment

To be aware of the environmental impact of digital technologies and their use.

22. How well do you understand safety issues in digital environments? Choose your level of proficiency for each competence.

	Not at all confident				Extremely confident
	1				5
Protecting devices	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Protecting personal data and privacy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Protecting health and well-being	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Protecting the environment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Section | Digital Competences Self-evaluation

5. Problem solving. Competences pertinent to this area are:

5.1 Solving technical problems

Your ability to identify technical problems when operating devices and using digital environments, and to solve them (from trouble-shooting to solving more complex problems).

5.2 Identifying needs and technological responses

Your ability to assess needs and to identify, evaluate, select and use digital tools and possible technological responses to solve them. To adjust and customise digital environments to personal needs (e.g. accessibility).

5.3 Creatively using digital technologies

Your ability to use digital tools and technologies to create knowledge and to innovate processes and products. To engage individually and collectively in cognitive processing to understand and resolve conceptual problems and problem situations in digital environments.

5.4 Identifying digital competence gaps

Your ability to understand where one's own digital competence needs to be improved or updated. To be able to support others with their digital competence development. To seek opportunities for self-development and to keep up-to-date with the digital evolution.

23. How fluent are you in problem solving? Choose your level of proficiency for each competence.

	Not at all confident				Extremely confident
	1				5
Solving technical problems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Identifying needs and technological responses	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Creatively using digital technologies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Identifying digital competence gaps	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

24. How do you rate the workshop?

Very bad					Very good
1					5
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

25. Your gender:

- Male
- Female
- Prefer not to say

27. Specialty or area of study:

28. Year of study:

29. You are from:

- City
- Village

30. Your age is:

- 18-20
- 21-25
- 26-36
- 37-47
- Over 48
- Prefer not to say

Appendix 2

Questions for interview to teachers

Question 1. In your opinion, what is the relationship between the concepts of information and digital literacy, education and libraries?

Question 2. Digital fluency is a relatively new term. Unlike digital literacy, which is understanding how to use technology and different tools, Digital fluency is the ability to create something new with them (new information, new product). How do you see the role of libraries/schools and universities in shaping Digital fluency among consumers?

Question 3. The seven elements of digital literacy are Media literacy, Information literacy, ICT literacy, Digital scholarship, Learning skills, Communications and collaboration, Career and identity management. How do you see the role of the library/schools and universities and the librarians/teachers and lecturers in the formation of each of them in the users/learners?

Question 4. Are the elements of Digital fluency (Curiosity fluency, Communication fluency, Creation fluency, Data fluency, Innovation fluency) important and if so why are they important to library users/students and librarians/teachers and teachers? Would you rank them in order of importance?

Question 5. What is the connection between Education 4.0, Industry 4.0, Internet of Things, Artificial Intelligence, Big data and libraries/schools and universities?

Question 6. In the heyday of fake news, what do you think are the skills we all need to be able to successfully distinguish between reliable and unreliable information?

Question 7. The topic of digital security is also extremely relevant. Is there a role for the librarian/teacher, teacher for the formation of such skills in users/learners and what is it?

Question 8. Why do you think technologies are important in the fields of education and research?

Dr. Marina Encheva is an Associate Professor at ULSIT, Bulgaria giving lectures and seminars in Electronic Resources, Information Analysis, E-learning, etc. She has worked as a librarian in AUBG and CAS. Encheva is a member of the EC of EBLIDA and of the Standing Committee of IFLA Section on Education and Training. In the period 2017-2023 she has been a coordinator of three Erasmus+ projects with target groups students, librarians and university teachers: “NAVIGATE: Information Literacy: A Game-based Learning Approach for Avoiding Fake Content”, “TLIT4U: Improving Transliteracy Skills through Serious Games” and “NEDLib: Digital Competence and Information Literacy for Librarians”.

Anna Maria Tamaro, PhD Information Science, is Editor in Chief of the Digital Library Perspectives and Editor of the Digital Heritage Column of the International Information and Library Review magazine. Since 2000 she has been teaching at the University of Parma and coordinated two International Masters taught in English: the MAIS International Master (International Master Information Science) and the Erasmus Mundus DILL Master (Digital Library Learning). She participates as team member to two Erasmus+ projects: “NAVIGATE: Information Literacy: A Game-Based Learning Approach for Avoiding Fake Content” and “TLIT4U: Improving Transliteracy Skills through Serious Games”. Her research interests include Digital library, Data curation, Media Information literacy.

Plamena Zlatkova was awarded a PhD degree in LIS in 2011. She has been an Assistant professor at ULSIT since 2008 giving lectures in Library Computer Technologies, Reference and Bibliographic Services, etc. Zlatkova has had experience as a librarian at the National Library. She has worked on a number of projects amongst which: “Developing a network of centers for continuing education of librarians servicing small municipalities”, “Digitalization of the Repertoire of the Bulgarian Literature of the Revival”, “Information Literacy: A Game-based Learning Approach for Avoiding Fake Content”. Zlatkova was a member of the EC of the Bulgarian Library Association (2012-2015).

Gergana Yancheva holds a PhD in Book Science, Library Science, and Bibliography. She is an Assistant Professor in the Department of Library Science at ULSIT. Yancheva is a member of the Society for the History of Authorship, Reading, and Publishing (SHARP) and the Bulgarian Library and Information Association. In recognition of her contributions, she was honoured with the “Honorary PhD Candidate” Award in 2018 by the University Youth Knowledge

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