European Union Digital Education quality standard framework and companion evaluation toolkit

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ABSTRACT

The Covid-19 pandemic positioned digital education in a new light. The need for educational institutions to develop strategies, standards and establish quality assurance across digital education became even more evident. This paper describes the four-step process of designing an interactive *European Union (EU) Digital Education Quality Standard Framework and Companion Evaluation Toolkit* to guide the design, delivery and evaluation of effective digital education. (1) A review of literature of existing digital education frameworks and models is presented. (2) Variables and sub-variables inherent in designing, delivering and evaluating effective digital education are identified. (3) Next the variables and sub-variables in the framework are defined. (4) The process of designing the interactive framework diagram is described with the companion evaluation toolkit outlined. The proposed framework is flexible and applicable to entities and audiences regardless of where they are in the online learning adoption process.

Introduction

Rapid technological changes over the last two decades have spurred new approaches to education. Digitally mediated teaching and learning have slowly been demanded and implemented in various educational contexts. In March 2020, with globally confirmed cases of COVID-19 more than 1.38 billion, learners were abruptly impacted (McCarthy, 2020). Eighty percent of learners were barred from their educational institutions as physical campuses shut down due to the need for social distancing (McCarthy, 2020).

This global educational disruption demonstrated traditional educational delivery systems do not have the scalability and adaptability required for the future of learning (Harari, 2018). Higher education administration had no choice but to pivot to and promote digital education in order to save students' academic year. Educational institutions and organisations around the world scrambled to provide learners at all levels with

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the opportunity to continue, complete and start new learning endeavours. Consequently, digital education enabled the education industry to continue functioning during a global pandemic. The speed of implementation of digital education abruptly changed in response to a desperate scramble to respond to university closures.

Proponents of online learning who had invested time and energy in convincing administrators, quality standards committees, funding agencies, and academic staff of the merits of digital education and the necessity of pioneering new approaches to teaching and learning to meet the needs of 21st century learners (Garrison, 2017), now had global support. Virtues of online education: quality, rigour, high levels of student engagement, and satisfaction, were supported by research to tout it as equal to, or superior to, face-to-face learning (Bell & Federman, 2013; (Legon et al., 2020; Wallace & Clariana, 2014). Online designers, developers, educators, and researchers were sought.

For academics with digital experience, online attributes were rapidly embraced as these educators used the flexibility, accessibility, and customisation, to transition face-to-face content to online platforms. Educators with less technological expertise were in a stressful situation having to convert face-to-face study-units to online study-units without adequate knowledge of how to design or deliver digital education. Yet despite some reluctance, digital education was rapidly acknowledged as the only educational solution available for educational organisations and consequently there was an unprecedented uptake (Kandri, 2020).

Educational institutions have been forced to review and amend existing policies and procedures in response to the need for clear and comprehensive long-term strategies for digital education implementation. There was overwhelming pressure for administrators to provide infrastructures that offer intentional development of educational support, effective tools for student engagement and academic staff training to ensure the quality of the educational experience (Kandri, 2020). Many administrators of fiscally invested institutions who had previously deemed online learning impractical, now, in this novel context, pivoted to online learning and became optimistic about the future of online education (PRWeb, 2020). The emergence of the new instructional paradigm requires all education institutions to develop a targeted implementation strategy. This demands effort as education institutions must not only devise and revise quality assurance protocols to extend to digital education delivery methods, but also ensure they focus on appropriate inputs, processes and outcomes.

The European Union (EU) has been tackling an imbalance in their higher education systems across states for several years, as described in the Commission's Digital Education Action Plan (European Commission, 2018). Historically, disparities in online education in European universities have been problematic as they create inequalities in the ability of populations to engage in learning opportunities. Further, the EU recognised the need to build resilience during this period of ubiquitous technological changes and increasing globalisation. This action plan has directed EU member states to plan and implement widespread reforms in higher education that provide flexible educational and training solutions corresponding to individual and community interests and labour market needs (European Commission, 2018). One prong of this action plan is the Erasmus+ funded, 3-year Digital Initiatives and Timely Solutions (DIG-IT) project (1 July 2019–30 June 2022).

DIG-IT provides solutions that address inequities in the production and delivery of digital education in the EU higher education system. Resources created in this project are

open source across the EU and encourage standardisation of infrastructure and online development across states. Quality online design is the cornerstone of this project, as learning materials require extensive upfront planning and design requiring an investment of time, effort, specialised resources, and skills (Andersson & Grönlund, 2009; Bates, 2015; MacDonald & Thompson, 2005).

With EU countries under pressure to offer digital education options, determining an appropriate theoretical framework was a logical first step. A curriculum framework acts as a credible, quality standard and guide for designing, delivering and evaluating effective education programs resulting in superior digital education experiences (Bates, 2015; C.J. MacDonald et al., 2010; C. J. MacDonald et al., 2009; Pawlowski, 2007; Thompson & MacDonald, 2005).

The following is an in-depth description of the 4-step process of designing a *European Union Digital Education Quality Standard Framework and Companion Evaluation Toolkit* to act as a quality standard and guide the design, delivery and evaluation of effective digital education.

Step 1 – Review of literature

Digital education frameworks identify, explain, predict, and demonstrate complex relationships between concepts, key and sub-variables, and best practices of digital educational phenomena. As technology changes exponentially and populations adopt novel ways to learn, the DIG-IT project team assessed if it were reasonable or feasible to adopt or adapt an existing framework or model. It asked: what are their strengths and shortcomings? Alternately, can relevant concepts from existing frameworks coupled with experiential knowledge and evidence-based practices be combined to create a new framework that extends existing knowledge and would be applicable for effective digital education in the EU in 2020 and beyond?

The project team agreed that the first step was to take advantage of previous work and research on digital education frameworks and models. As digital educational solutions have been used for over two decades across disciplines, demographics, and geographical boundaries, several models and frameworks exist.

An integrative literature review was carried out to explore available models and frameworks for online learning in higher education settings with the intention of gathering insights, perspectives, strengths, and deficiencies. The goal was to conduct a thorough analysis, and synthesis of existing frameworks and model components and combine it with local experiential knowledge, to create a robust, novel framework to guide the design, delivery, and evaluation of digital education processes and products at EU universities and healthcare organisations.

Methodology

In 2019, an integrative literature search following Torraco's (2016) guidelines was performed to detect available models and frameworks for digital education in higher education. Research platforms included: Eric, PubMed, Cinahl and Scopus. The search was conducted using a combination of the following search terms: framework, model, eLearning, online, digital and web-based learning and higher education. Included articles

were published in English within the last 20 years and had either a framework or model on digital education in the higher education setting. Articles were excluded if they were published prior to the year 2000 or did not specifically refer to an eLearning or digital education framework or model. However, the reference lists of omitted articles were screened to identify potential additional relevant articles.

Study selection, data extraction and data synthesis

Results from the database searches were imported and merged into the Mendeley Web Reference Management software, and duplicates were removed. Six reviewers independently screened the search results by title and abstract. The reviewers independently extracted the following information from the studies: first author, year, name of model/framework, target audience, model description, model variables, strengths, and areas for development. Relevant information from retrieved articles was extracted for a narrative synthesis of the findings from different studies; this method was chosen because reviewers agreed it was the best way to synthesise findings from diverse studies (Schwarz et al., 2019). Results are summarised in Table S1[1] which can be viewed online at http://project-digit.eu/index.php/review-of-literature-summary/. Reference lists of all the included papers were searched to identify articles that qualified search criteria and may have been missed in the electronic searches.

Results

The electronic search identified 6,207 potentially relevant articles. In the first phase, specific keywords and limitations were agreed upon and reviewers decided to concentrate on frameworks or models of digital education. At first reviewers read the titles. If the title included some of our keywords (digital education, eLearning, online learning, web-based learning, framework, model, higher education), it was imported in the folder 'Title' in Mendeley. After that the abstracts were read and if it included an online framework or model, it was imported in Mendeley folder 'Abstract'.

In the last phase reviewers read the full texts. If the article included an online framework or model, it was imported in Mendeley folder 'Full text' of which 112 articles remained for full-text assessment after the title and abstract screening. A total of 32 articles were deemed eligible. Five other relevant publications were identified through the reference list searches of the included studies. Therefore, a total of 37 studies were included in the final review.

Analysis of educational frameworks

Although many digital education frameworks and models have been developed, they differ substantially in their components and over time. For example, Khan's (2000) framework identified eight dimensions that can contribute to the success of eLearning: pedagogical, technological, interface design, evaluation, management, resource support, ethical and institutional. The pedagogical dimension, for example, relates to the teaching and learning process, the institutional dimension focuses on administrative and academic

affairs, and the technological dimension deals with technological issues. This model is one of the few that considers social and cultural factors.

The CSALT networked learning model developed by Goodyear (2001) includes both constructivist and cognitive principles and provides a pedagogical framework as well as an overview of the broader issues surrounding eLearning. The model aims particularly at educators in higher education.

The Organisational Absorptive Capacity for eLearning model, developed by Martin et al. (2003), discussed how organisational and contextual issues moderate eLearning uptake. The authors focused on aspects such as who participates in organisational eLearning, what are their attitudes to technology, motivations to learn, and under what context. They stressed that the diffusion and effectiveness of digital education are moderated by the technological infrastructure, government/organisational inducements, as well as by perceptions of crises in education and the need to promote relevant changes.

Haw et al. (2015) proposed a multidimensional framework entitled LearnCube. With its six main dimensions with 18 sub-dimensions, the emphasis of the LearnCube lies on user demographics of the personnel involved in the teaching and learning process (e.g., teachers and students) and the inter-relationship among the attributed dimensions.

Although research on educational frameworks is abundant, it is disparate. While all frameworks and models focus on essential dimensions and perspectives of digital education,few considered all components together. Specifically, most frameworks and models did not consider ethical, cultural, or institutional aspects and needs of digital education, such as technical support and learner engagement, together which is deemed important . Further,when designing the interface of online learning tools both usability and social presence are essential. Pecka et al. (2014), for example, noted the importance of mutual respect for and trust in colleagues for effective online environments as this can increase cohesiveness. Some of the reviewed literature included the words 'community' and 'sense of belonging', others discussed how a Community of Inquiry Framework (Arbaugh, 2008) supports social presence thus contributing to online learning success.

The aim of the DIG-IT project is comprehensively to address designing, delivering and evaluating effective digital education. Therefore, the project team took the relevant variables and sub-variables from each of the framework and models, added the experiential knowledge of experts from the six Erasmus partners from five countries, in university and industry, to create a pliant, holistic, futuristic Digital Education Quality Standard Framework. This process ensured that the framework included everything that needed to be considered when designing, delivering and evaluating digital education.

Step 2 – Operationalising the key elements of online learning

The table resulting from the review of the literature was reviewed by six researchers to identify best practices and important elements for effective online learning (see Table S1[2]). Redundant or overlapping variables and sub-variables from existing frameworks and models were merged, collapsed then reviewed. Desirable variables and sub-variables were identified and grouped under thematic headings representing best practices.

Verbatim definitions were used where possible from the original framework article. When elements were unclear or needed to be contextually modified, terms were

researched and discussed by the team to clarify the intended meaning of the element in the context of the framework.

The framework was then analysed variable by variable using the list of definitions to determine their relevance and placement in the framework. Over several analytical iterations, new elements were added. For example, the term 'communication' was not in the initial draft yet on review was deemed important to an effective learning environment and added under 'community'. The terms intentional, communication, participation and culture were final terms that were added to the initial framework.

The variables and sub-variables were operationalised based on information from the literature review and the collective practical experience, knowledge and best practices of experts who have been involved in researching and teaching digital education frameworks, and in best practices in designing, delivering and evaluating digital education, for the past twenty years (see Table 2[3] for definitions of variables and sub-variables, this can be viewed online at http://project-digit.eu/index.php/review-of-literature-summary/).

Based on an extensive review of the literature, it became clear that effective digital education requires thoughtful and skilful design of the following variables: content, delivery, support, community and structure. Carefully implemented learner assessment and program evaluation are essential to the success of a digital education program. Commitment to continuous improvement through emerging design ensures that digital education continues to meet evolving learning needs and leverage advancing technology. Effective digital education leads to learner and academic staff satisfaction, increased learner knowledge and skills, the transfer of knowledge, and a positive impact on the organisation. All variables and sub-variables in this framework are considered essential to effective digital education design, delivery and evaluation. It is recognised that these variables and sub-variables are not isolated entities – there is overlap and redundancy between and among them. It is also clear that the descriptions for many of these variables and sub-variables could go under various terms or titles. It is the 'concept' and the collective application of these variables and sub-variables that result in effective digital education practice.

Step 3 – Creating the Erasmus+ EU framework diagram and digital tool

The design team, several with over twenty years' experience of pioneering the design, delivery and evaluation of online learning courses, resources, frameworks and assessment tools, used the variables to create a draft EU digital educational framework diagram. The diagram is a visual representation of the variables and the relationship among them deemed essential to consider when designing, delivering and evaluating effective online learning. The framework is accompanied by definitions of the variables to facilitate context and understanding. The framework is not intended to be a step-by-step guide on how to design, deliver and evaluate online learning, but a quality standard highlighting the essential aspects of online learning that must be considered.

A two-step methodology was followed, as seen in Figure 1. The first step, which aimed at visualising the framework in a way that would properly express its theoretical underpinnings, consisted of several iteration cycles of conceptualising a visualisation, designing it, and collecting feedback (Figure 2). For the second step, aimed at designing and developing an online interactive tool that depicts the framework, the classic Waterfall (Royce, 1987) Software Engineering Methodology was applied. In this methodology, the
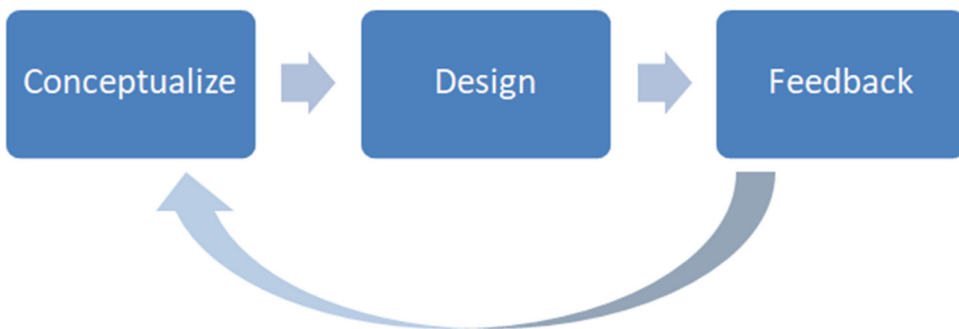
Figure 1. The two-step methodology.

Figure 2. Visualisation (step 1) methodology.

activities of development are broken down into sequential steps, with each phase depending on the results of the previous one. Each phase can be revised after feedback (i.e. via discussions with consortium partners and/or evaluations with users) and should be finalised before proceeding to the next one.

Visualising the framework

In total there were five main framework design versions (i.e. conceptualisations), with each having multiple design variations respectively. The draft versions can be seen at http://project-digit.eu/index.php/versions-of-framework-designs/. For each design (main framework and variations), the first step included its conceptualisation, based on the team's ideas and discussions with the partners, while the next step was to design a draft version of the specific concept and subsequently to collect feedback on it from the partners. Following feedback collection, an iteration cycle would occur back to the conceptualisation step, in order to improve on the current design or to produce a new one.

In time order, the five main framework conceptualisations produced were:1) triangle framework; 2) circles and boxes framework; 3) layered onion or eyeball framework; 4) puzzle framework and 5) connectivity framework. All conceptual frameworks are discussed below, along with their respective design variations.

Triangle conceptual framework

It must be noted that the original draft triangle framework was based on the initial review of the literature and designed by a researcher with significant experience in designing conceptual frameworks. It was presented to the group of researchers (i.e. the Erasmus+ partners from universities in five EU countries: Slovenia, Cyprus, Italy, Finland and Malta and Saint James Hospital) at the project kick-off meeting in Malta in October 2019. This was the basis from which the extensive visualisation methodology was initiated. The process of designing the conceptual framework was explained and the variables and sub-variables operationally defined. A discussion followed in which variables and their relationships were debated. The discussion was audio-recorded and extensive notes were taken. It was decided to extend the review of the literature to include five databases instead of two and to depart from the triangle design.

Circles and boxes conceptual framework

Following the triangle design, the design with circles and boxes was considered. It had a high number of variations since there was ample scope for creativity with this type of design.

Layered onion or eyeball conceptual framework

Next, consideration was given to the layered onion or eyeball design. This was inspired by the research onion model (Thornhill et al., 2009) which has been adapted in many different contexts, including the COVID-19 pandemic environment.

Puzzle conceptual framework

This was an extremely difficult design to visualise since it was challenging to depict the connections between all the variables, so as to ensure that every variable of the framework is connected. Hence, it was decided to initially produce the designs on paper before moving to digital design. In the end, it was not possible to create those required relationships and thus, this design was not visualised digitally. Other partners had also contributed to the designs.
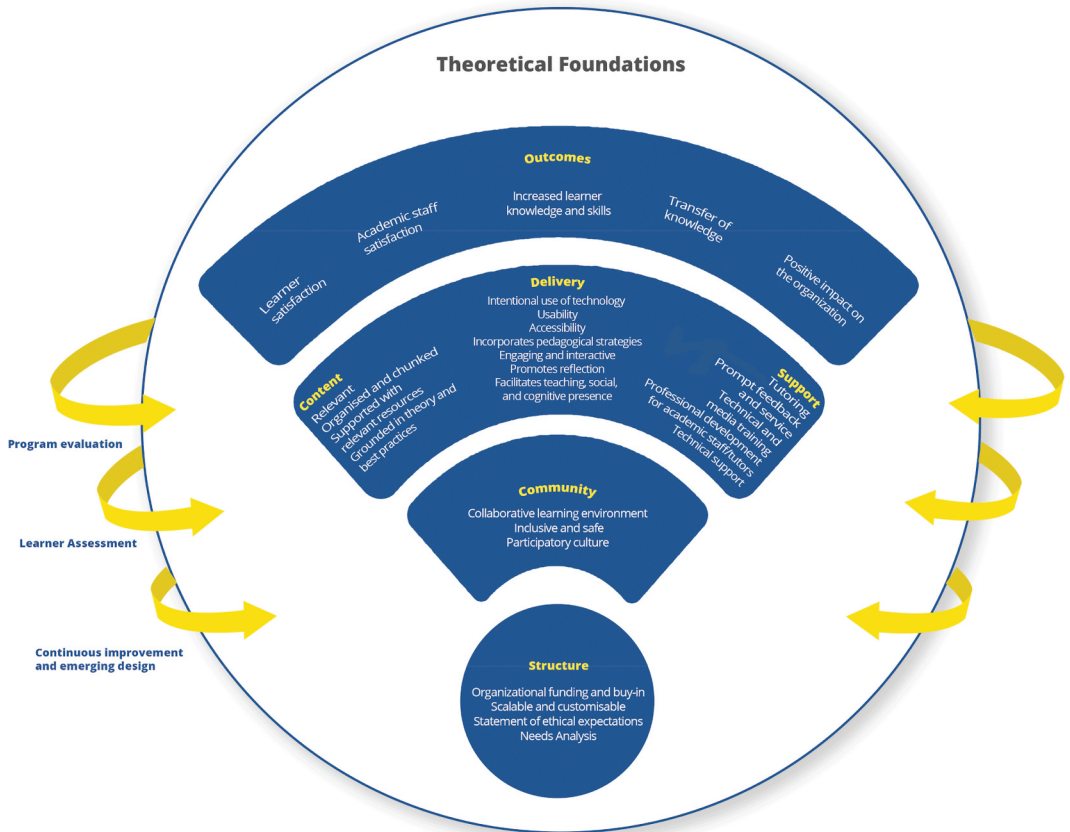
Connectivity conceptual framework

The connectivity design, inspired by the wi-fi logo, was the one selected to be developed. The team liked the symbolism of the connectivity sign in digital education. Also, a positive point was that it was not seen as being used in other frameworks, making it novel, and it diverted from the rather tired triangle, puzzle and onion layer figures.

The chosen connectivity conceptual framework design subsequently developed is displayed below as Figure 3. See also the final interactive European Union Digital Education Quality Standard Framework and Companion Evaluation Toolkit. The interactive version is accessible on the project website.[4] Within the interactive tool one can click on any variable or sub-variable in the framework to access the definition.

Process of framework updates and feedback collection:

Changes based on group discussion notes were made to the original draft framework (i.e. Triangle Conceptual Framework) and several revised frameworks were emailed to all participants for additional feedback. Each framework had several iterations (i.e. variations)

Figure 3. The final framework design (i.e. connectivity design inspired by wi-fi logo).

that were likewise emailed and discussed until saturation was achieved, no more changes were suggested and all partners agreed the framework was appropriate for their needs.

Finally, after 12 months of reviewing the literature, identifying and operationalising the variables and sub-variables, and designing and programming the framework, the DIG-IT research team agreed upon the final version. Table 1 displays a summary of the designs and the limitations perceived by the consortium for each.

Table 1. Designs and limitations.

| Conceptual framework	Limitations
Triangle	• Perceived as linear.
	• Too similar to other frameworks.
Circles and Boxes	• Some variables are perceived as more important than others.
	• Difficult to follow the story.
Layered Onion or Eyeball	• Some team members felt that the layered onion was overused.
Puzzle	• Perceived as elementary.
Connectivity	• Connection to the internet was perceived as a plus positive. Seen in other instances so perceived as novel. The triangle and onion/eyeball perceived as overused and tired.

Designing and developing the digital tool

The Waterfall Methodology as used in this work, is displayed in Figure 4.

During the analysis phase, the requirements for the online tool were gathered through discussion sessions with the partners. The tool was envisioned to be interactive, and responsive, presenting and giving access to all the theoretical information, in an accessible, easy to use manner, and was designed accordingly during the design phase.

The tool was implemented, on top of a WordPress CMS platform as a plugin, exploiting the HTML ImageMap feature. This feature maps each given set of coordinates on top of an image to programming functionality. For the development, the team used web technologies including PHP, JavaScript, HTML and CSS. To simplify the design of the tool, no database was used, as no new data can be received or stored from the users and the framework is meant to be permanently defined in the way it is presented in the first version. To conclude the development and testing phase, the tool was tested by both the developers' team and the other partners as plain users, feedback was gathered and fixes were applied. Then the tool was deployed for open use. An evaluation is planned in the coming months.

Step 4 – Companion evaluation tools

The final outcome described is a companion evaluation toolkit consisting of a formative, quantitative survey, 'temperature check', a summative quantitative survey, and a follow-
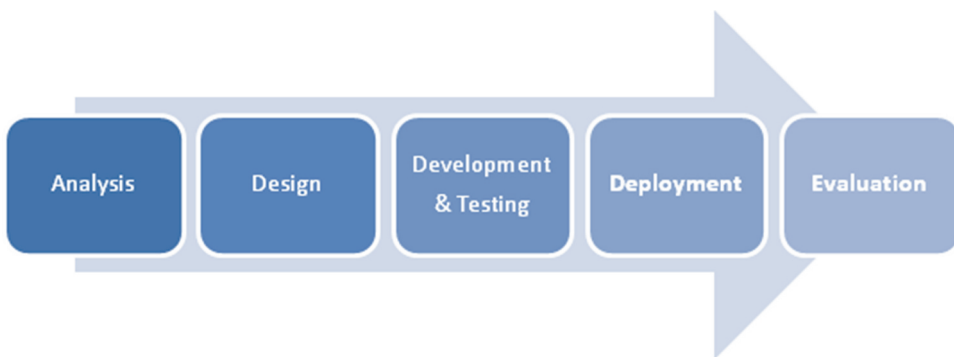
Figure 4. Platform development methodology.

up qualitative interview protocol to assess programs using the framework. The instruments can be accessed by clicking on the word Toolkit in the right upper corner of the framework figure.

Temperature check

Temperature Check is the name given to a brief quantitative Likert scale online survey including two quantitative open-ended questions soliciting information on the EU Digital Education Quality Standard Framework variables (content, delivery, support, structure, community, and outcomes). The anonymous temperature check takes learners approximately 5 minutes to complete. The purpose of the temperature check is to obtain feedback early in the course so that any minor concerns can be addressed before they become major issues.

Examples of temperature checks designed by an experienced program evaluation researcher and digital education expert were sent to the evaluation team. Using these samples, a draft temperature check was designed by an evaluation team member and circulated to the evaluation team for feedback. Several edits and changes were made by team members before all were satisfied that the temperature check instrument would be effective at collecting data to inform digital educators regarding learner satisfaction with the course and whether changes are required either immediately or in the next course offering. The temperature check instrument is currently being used and data collected so that it can eventually be validated.

Summative evaluation

The brief summative qualitative Likert scale online survey including quantitative open-ended questions also solicits information on the EU Digital Education Quality Standard Framework variables (content, delivery, support, structure, community, and outcomes). The anonymous summative survey requires learners approximately10 minutes to complete. The purpose of the summative survey is to obtain feedback at the end of the course so that any necessary changes and improvements can be made in the next iteration of the course.

Examples of summative online course evaluation surveys designed by an experienced program evaluation researcher and digital education expert were sent to the evaluation team. Using these samples, a draft summative evaluation instrument was designed by an evaluation team member and circulated to the evaluation team for feedback. Several edits and changes were made by team members before all were satisfied that the summative evaluation instrument would be effective at collecting quantitative and qualitative data to inform digital educators on learner satisfaction with the course and if changes are required in the next course offering. The summative evaluation instrument is currently being used and data collected so that it can eventually be validated.

Interview protocol

The interview protocol provides sample open-ended questions that could be used to solicit detailed follow-up data and triangulate information obtained from the temperature

check and summative survey. Original questions were drafted by an experienced program evaluator researcher and digital education expert and sent to the evaluation team. Several edits and changes were made by team members before all were satisfied that the interview protocol questions would be effective at collecting in-depth follow-up data to inform digital educators on learner satisfaction with the course and if changes are required in the next course offering. The summative evaluation instrument is currently being used and data collected.

The details of the design of the evaluation tools and the process of validating them will be the subject of a follow-up paper in the near future.

Conclusion

This paper described the process of designing an EU Digital Education Framework and Companion Evaluation Toolkit. The interactive framework resulted from best practices from existing frameworks and models in the literature from across the globe coupled with the experience of digital education researchers from 5 EU countries participating in an ERASMUS+ project. The framework comprises definitions of the variables and sub-variables to facilitate context and understanding. Moreover, the visualisation of the framework presents the relationship among the different variables. This feature of the framework is believed to be a unique contribution to the world of digital education. The framework and toolkit are proposed as quality standards to guide the design, delivery and evaluation of effective digital education across the EU and the wider international context.

The framework is not intended to be a manual on how to design, deliver and evaluate online learning, but a quality standard highlighting the essential variables and sub-variables of digital education that must be considered and the relationship which is to be fostered amongst the different variables and sub-variables. The framework and toolkit are to be used and employed in a flexible and adaptive manner, and are applicable to education and training institutions, industries, and audiences regardless of where they are in the online learning adoption process. The use of this sound adaptive framework and toolkit across different contexts and countries should translate into enhanced quality assurance and also increased harmonisation and transferability of digital education initiatives. The value of this framework and toolkit are timely given that digital education is experiencing an unprecedented boom, and credibility and quality standards are needed.

Notes

1. http://project-digit.eu/index.php/review-of-literature-summary/.
2. http://project-digit.eu/index.php/review-of-literature-summary/.
3. http://project-digit.eu/index.php/definitions-of-variables-and-sub-variables/.
4. Interactive framework: http://project-digit.eu/index.php/digital-education-quality-standards/.

Disclosure statement

Funding

Notes on contributors

Colla J. MacDonald won the titles of Distinguished University Professor and Professor Emeritus from the University of Ottawa prior to taking early retirement in 2016 and accepting a role as Senior Researcher at the University of Malta. She has demonstrated a cutting-edge vision for education that is recognised around the world.

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Insa Backhaus holds a PhD in Public Health from the Sapienza University of Rome, Italy. She received her BSc in European Public Health and her MSc in Healthcare Policy, Innovation and Management from the Maastricht University in the Netherlands. Her principal area of interest, as well as recent research, has been in the field social epidemiology. Her research is focused on college student mental health, with a particular interest in the association between social capital and depressive symptoms. With collaborators at universities across world, Dr. Insa Backhaus is conducting a two-wave panel study on the influence of social capital and college student mental health. Dr. Backhaus also works on projects related to LGBTQ college student mental health. [insa.backhaus@uniroma1.it

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