Panagiotakopoulos et al. *Research and Practice in Technology Enhanced Learning* (2024) 19:13
https://doi.org/10.58459/rptel.2024.19013

Research and Practice in
Technology Enhanced Learning

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A competency-based specialization course for smart city professionals

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Abstract

Intelligent technologies permeate all aspects of contemporary society and urban life. It is essential to educate the workforce of smart cities in order to effectively meet emerging technological demands. In this paper, we present an e-course that focuses on discrete competencies associated with different smart city roles. Initially, we present the conceptual learning framework for the development of the competency-based learning course and we define the objectives of the research. The paper continues with a discussion of the model's application steps and an examination of the course's skills, competencies, and roles. The acquired knowledge was measured using pre- and post-course tests, and questionnaires were used to investigate the relevance and quality of the learning material and the learning acquisition of the participants. Evaluation results showed that the course was relevant to the concept of smart cities, useful for their work duties, while participation in the course resulted in increased overall competency in all three smart city job profiles.

Keywords: Smart cities, Smart city workforce, Professional development, Continuing education, Online learning, Lifelong learning

Introduction

The digital transformation of urban environments enables the concept of the "smart city" to be realized, which refers to an "instrumented, connected, and intelligent city" (Harrison et al., 2010). Services and infrastructures of cities are constantly upgraded cross-sectorally to keep pace with and benefit from technological advancements (Ahad et al., 2020). Increased use of information and communication technologies (ICTs) facilitates the development of new functions of urban intelligence and the establishment of online and mobile modes of participation (Batty et al., 2012). The "Internet of Things" is another critical component of smart cities' ICT infrastructure (Bibri, 2018), along with artificial intelligence, cloud computing, cyber-physical systems, and communication technologies.

Although technological developments and urban innovation provide many opportunities for improved and sustainable urban management, their potential can only be realized to a certain extent without skilled and talented people (Hollands, 2020). However, as several studies indicate, smart cities face substantial shortages in skillful employees with the skill supply lagging behind demand in various domains (Ahad et al., 2020; OECD, 2020; Sanchez-Ortiz et al., 2020). Therefore, educational and training programs are imperative to reinforce the human capital of smart cities with appropriate skills (Zhuhadar et al., 2017). Taking into account that the majority of the people that will be needed to support transition and operational needs of smart cities have already fulfilled their basic studies, it is important to focus on continuing education aiming at upskilling and professional development of the existing workforce (Curşeu et al., 2021). Continuous education not only will assure a well-trained workforce capable of effectively dealing with diverse smart city planning and operational needs, but will lead to career sustainability for all citizens fostering social cohesion and inclusion and ultimately smart cities' sustainability (Ramaswami et al., 2016).

Professional development is evidently deemed important for a fair, efficient and sustainable transition towards smart cities. However, the training offer for upskilling smart cities' workforce is very limited and, with regard to the public sector employees, largely inadequate (OECD, 2020). Specifically, so far, no systematically developed integrative lifelong training program has been put forward on the basis of well-defined smart city skills/competencies. To address this gap, we developed a labor market-driven, three-stage continuing education program for upskilling smart city professionals (Iatrellis et al., 2021). This paper describes a specialization course built upon discrete competencies, which was delivered on the second stage of this program and examines its efficacy in competency development for smart city professionals. The course has three learning paths adapted to the needs of three emerging smart city job profiles. Competency-Based Learning (CBL) is a student-centered, outcome-based approach to learning in which students progress to more advanced work after mastering prerequisite content and skills (Henri et al., 2017) and has been found to be very effective for professional development (Zhang & West, 2020).

In the rest of the paper, we first review works relevant to smart cities education and the application of CBL and then in the section "Research framework and objectives" we discuss the framework supporting the conceptual design of our course. The section 4 "Specialization course" presents the design, implementation and deployment of the competency-based e-learning course. Next, the section "Evaluation method" discusses the evaluation methodology and in the section "Results" we present the results of the evaluation. In the section "Discussion" we discuss the main findings and the section "Conclusion" concludes this paper.

Literature review

The literature in smart and sustainable cities has widely recognized education as a fundamental component for the effective transition of cities to a digital era. Considering the training offer for upskilling a smart city workforce, in which this study is positioned, Zhuhadar et al. (2017) argue that productivity is now led by innovation in smart cities and, thus, a strong knowledge infrastructure and skillful labor are major requirements and investment priorities. Building urban governments' capacity to plan and implement successful smart city interventions, requires modernization of vocational education and training as well as of higher education curricula (Avdeeva et al, 2019). The CAP4CITY Erasmus+ project deals with smart sustainable cities having as one of its main goals the design of training modules that would reflect the needs of the Latin American region (Sanchez-Ortiz et al., 2020). Nine themes/groups of competencies were identified and updated curricula in formal education and lifelong training through Massive Open Online Courses (MOOCs) to cover the skill demand were suggested.

With MOOCs being a popular solution recommended by various other researchers, work-based learning (Markow et al., 2019), the use of social networks for improving the knowledge of stakeholders in the context of smart cities (Qureshi et al., 2014), bootcamps (David & McNutt, 2019), e-learning (Garg et al., 2017) and collaborative learning platforms and distance education (Kumar et al., 2020) have been also proposed. Looking beyond corporate training programs that almost exclusively focus on specific, often inherently technological fields, such as cloud computing, data analytics and data management, only a few actual implementations of smart city-oriented lifelong learning programs have been reported in the literature.

A MOOC has been developed to support urban change and participation in smart cities (Hudson et al., 2019). The goal of the MOOC was to facilitate attitudinal learning about smart cities and to investigate whether learners participate in local smart city activities. The course's goal was to provide a resource for citizens to learn about the role of technology and data in cities, as well as how they can participate in the creation of smart cities, without however addressing the needs of the smart city workforce. Moreover, Jaskiewicz et al. (2019) explored the use of hackathons where participants learn both technical skills and new perspectives on city problems from each other towards initiating and developing smart city projects. Nevertheless, these works target citizens and not professionals and are mostly topic-based approaches, which are largely disconnected from the pressing labor market needs.

The above works indicate that the literature has recognized the need to upskill the smart cities workforce, has done a lot of progress in identifying the skills that this workforce should have and determined the most prominent training approaches that should be adopted. However, continuing education programs for smart city professionals are quite rare creating the need to design, develop and evaluate such programs, in order bridge the gap between the training demand and offer in smart cities.

CBL is effective especially in interdisciplinary fields such as smart cities, because it is a student-centered approach that leads to students becoming more autonomous (Spelt et al., 2015). Based on data from the 2018 National Survey of Postsecondary Competency-Based Education (NSPCBE) implemented by the American Institutes for Research, institutions see CBL as a way to serve non-traditional students and improve workforce readiness (Lurie et al., 2019). The competency-based approach was one of the most suitable teaching methods to implement during the covid-19 pandemic due to its clear learning stages, anticipated competencies, and targeted knowledge. Adopting a competency-based approach to online learning ensures completion of educational goals and achievement through interaction, flexibility, and accessibility (Mallillin et al., 2021).

CBL is a teaching strategy with measurable outcomes. Hence following such an approach in a specialization e-learning course is an interesting research direction with probable immediate practical outcomes. Competency-based e-learning has already been implemented in health sciences, and although it was logistically and instructionally more challenging to develop it was more effective in terms of learning outcomes (Sistermans, 2020). Theoretical and applied perspectives are provided in Henri et al. (2017), addressing both the theoretical basis for CBL's effectiveness and the practical aspects of successfully implementing CBL instruction in engineering education.

Building upon the above studies, in the current work we present a specialization course, which was developed by integrating CBL techniques to reinforce their practical competencies. Since there are only a few courses available for smart cities, our work will cover the need for practical training directly connected to the labor market requirements, researching the application of CBL in this field and the opinions of the participants with respect to the provided training.

Research framework and objectives

Competency-based learning entails a comprehensive student learning process that includes specific objectives, alternative materials and representations of the negotiated concepts, and assessments to assess students' achievement of the objectives. The main purpose of the present work is to develop a specialization course to help employees and prospective employees of smart cities to acquire specific competencies.

The specific research objectives of the current work are *i.* To develop a competency-based training program which would be useful to the current and future employees of smart cities, *ii.* to assess whether the offered competencies are relevant to the everyday duties of employees of smart cities, and *iii.* to support participants in acquiring practical competencies on smart city topics.

The conceptual learning framework to develop the CBL course was based on the hierarchy of postsecondary outcomes model (Jones et al., 2002) (Figure 1). According to this model the characteristics of the learners are taken into consideration and through the learning experiences, skills, knowledge and abilities are promoted and transformed to competencies which at the end can be demonstrated. Assessment extends throughout the levels of the model to ensure that the desired results are achieved.

To apply the model, we followed a methodological approach consisting of the following stages, which are described in detailed in the next section:

1. Recognition of the characteristics and knowledge of the prospective trainees.
2. Definition of the targeted competencies and the required skills and knowledge to achieve them.
3. Establishment of the assessment mechanisms.
4. Development of the online materials, delivery and monitoring mechanisms for the course.
5. Forming an evaluation methodology to assess the success of the endeavor.

Specialization course

Learning paths and competencies to be taught

Aiming to address the smart cities employees' skill readiness challenge and develop high-

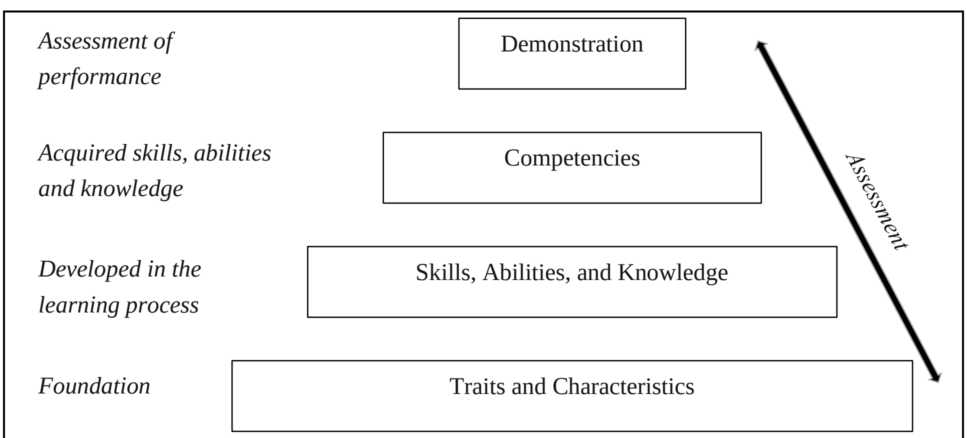

Fig. 1 A hierarchy of postsecondary outcomes model

quality lifelong training solutions to the smart cities' workforce, we concentrated on bridging the gap between available and required skills of people that already work or will work in, with and for smart city municipalities. To this end, we initially focused on identifying emerging job profiles and skills in a smart city career ecosystem. Our research revealed three primary smart city job profiles (Panagiotakopoulos et al., 2022), which are briefly described as follows:

- *Smart City Planner:* a high level official capable of mapping city needs to smart and sustainable solutions. A smart city planner shall have an overall understanding of the city's strategic objectives and support a twofold role by defining the digital transition roadmap and monitoring and assessing its implementation
- *Smart City IT Manager:* a smart city executive responsible of selecting, implementing and continuously monitoring the most appropriate ICT solutions to achieve the goals set by the city's strategic plan, while managing IT projects and staff among others.
- *Smart City IT Officer:* an IT expert mainly focusing on the design, development, testing, deployment and monitoring of new IT systems and services.

Moreover, we identified a group of 42 emerging skills, which were ranked as the most important for smart city professionals and were classified in four categories (Figure 2): soft/transversal, digital (e.g., introduction to cloud computing, IoT and artificial intelligence), DevOps (e.g., continuous integration and configuration management) and smart city specific (e.g., smart city platforms and urban management).

Subsequently, these skills were mapped to the three previously mentioned smart city job profiles forming three distinct competency-based educational curricula, one for each job role. 15 of these skills (e.g., DevOps basic concepts, basic concepts of cloud computing, basic concepts of data analytics, Smart cities platforms, basic concepts of Internet of Things, Social skills, etc.) were common for all three job profiles and were offered in the first stage

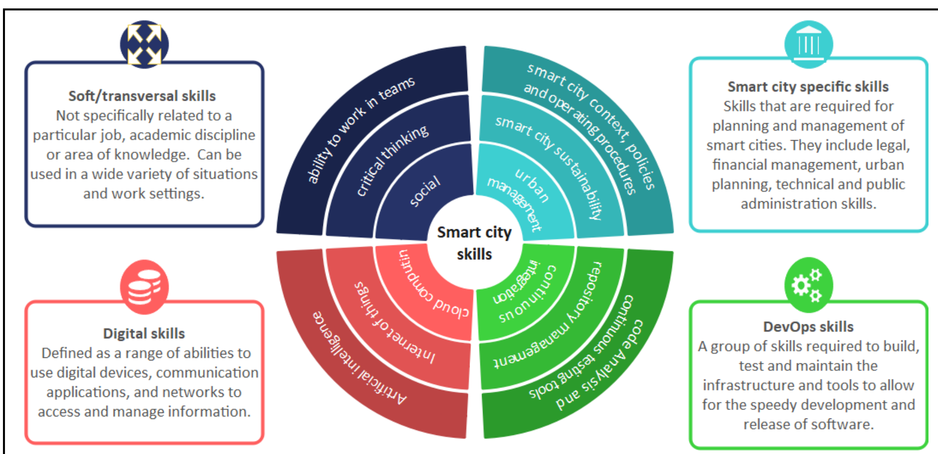

Fig. 2 Smart city skill categories and examples

of our training program (i.e., the MOOC) (Kostopoulos et al., 2021). The competency-based specialization course covered the rest of the skills (n=27), which formed three learning paths (see Figure 3), one for each job profile, which learners that had successfully

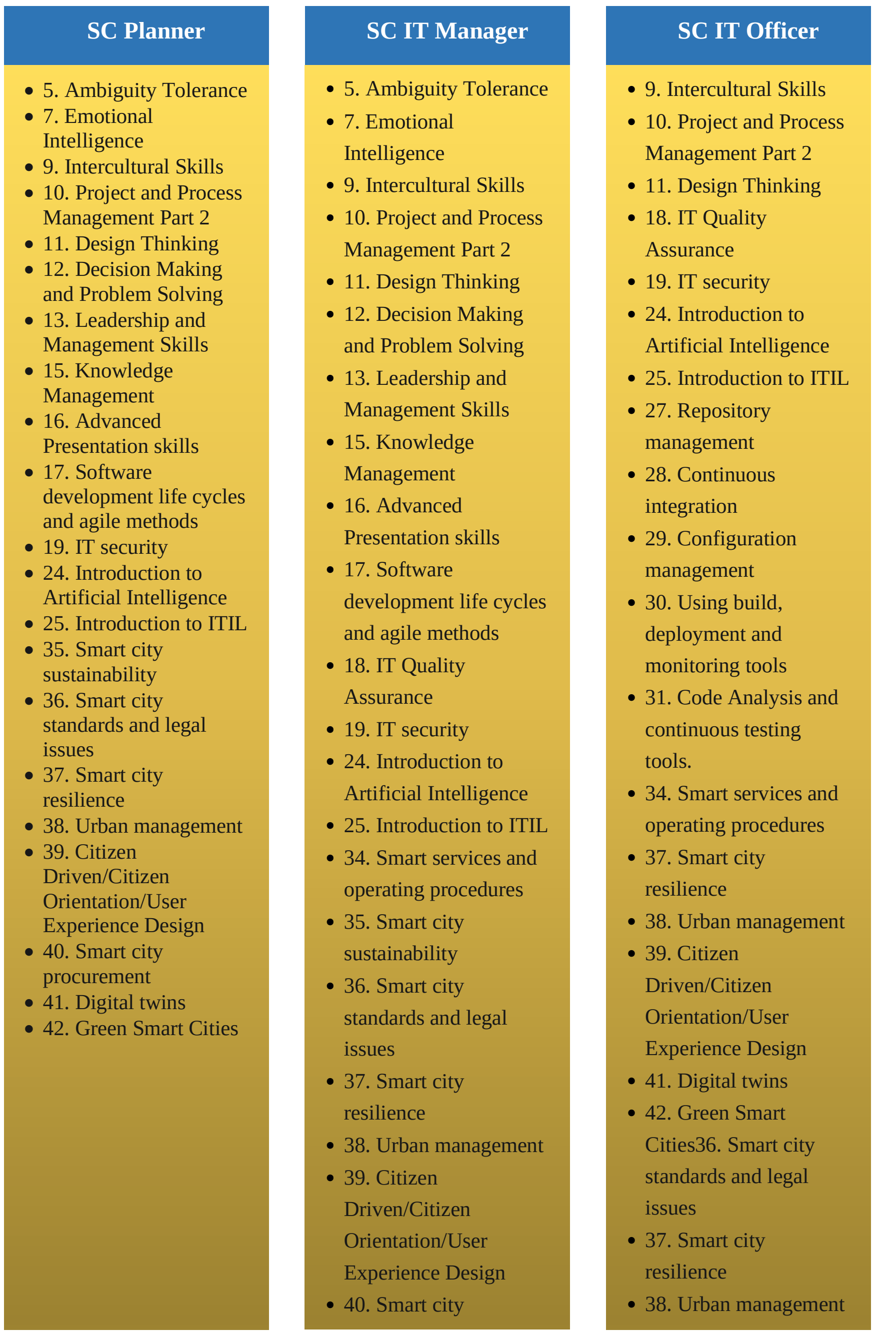

Fig. 3 Specialization course learning paths

finished the MOOC could enroll to (it is noted that skill project management was split in two learning modules increasing the number of skills included in the specialization course to 28). Each interested participant could select only one learning path to attend during the specialization course, in order to pursue a certification for his/her preferable job profile.

Characteristics and prior knowledge of the trainees

As previously described, the specialization course participants were drawn from the pool of individuals who had previously successfully completed the MOOC, the first stage of the comprehensive continuing education program for smart city professionals we piloted. These people were asked if they wanted to participate in the next stage and those who responded positively were enrolled in the specialization course. All MOOC and, consequently, specialization course participants fell into one of the following categories: civil servants, employees of companies (e.g., IT, construction, etc.) involved in smart city projects, individuals working as subcontractors for smart city municipalities (e.g., engineers, software developers, etc.) and people able to work in the aforementioned positions based on their acquired or pursuing academic and professional degrees (e.g., in engineering, public administration, digital systems, etc.). This was ensured after screening the MOOC registrations and removing all non-eligible registrants (Panagiotakopoulos et al., 2021).

Thus, specialization course participants can be considered either as current as prospective smart city professionals with a varying level of theoretical and/or practical knowledge on smart city topics and domains. This group of participants formed the foundation part of the applied model. All the learners were adults with various family and working obligations which made asynchronous e-learning the only feasible solution for delivering the course.

Course design and development

The design phase of a course is vital for the eventual deployment of the course. The purpose of this phase is to quantify the objectives and to detail the course structure.

The main outputs of this phase are:

- *Course structure:* a detailed description of the course's structure which fulfils the aims of the course.
- *Course module description:* a detailed description for every course module and association with specific competencies.
- *Course units (learning activities) description:* a detailed description of the units per course module.
- *Learning objects:* a detailed description of the learning objects per unit.
- *Learner assessment description:* a detailed description of the learner assessment of the course module / unit.

Following the nine steps of Gagne's instructional design theory (Gagne et al., 2005) all the materials start with a short description of the material to activate the trainee's attention (see Figure 4); the material is connected to prior relevant content; the content in presented in alternative forms (pdf, PowerPoint, video clips, interactive materials, etc.); guidance is provided through examples, forums, email support, external resources and frequent synchronous sessions (see Figure 5); practical exercises and case studies for each concept are included; automated feedback or specific model solutions are provided; performance is assessed through various practical activities and quizzes (see Figure 6); and thus through these learning experiences the trainees develop the skills which are gradually transformed to competencies.

For each competency the learning outcomes were initially established and then one or more learning objects implementing the Gagne's step were developed to address them. The material was developed by domain experts with the guidance and assessment by instructional specialists. A group of four European universities two city associations a VET

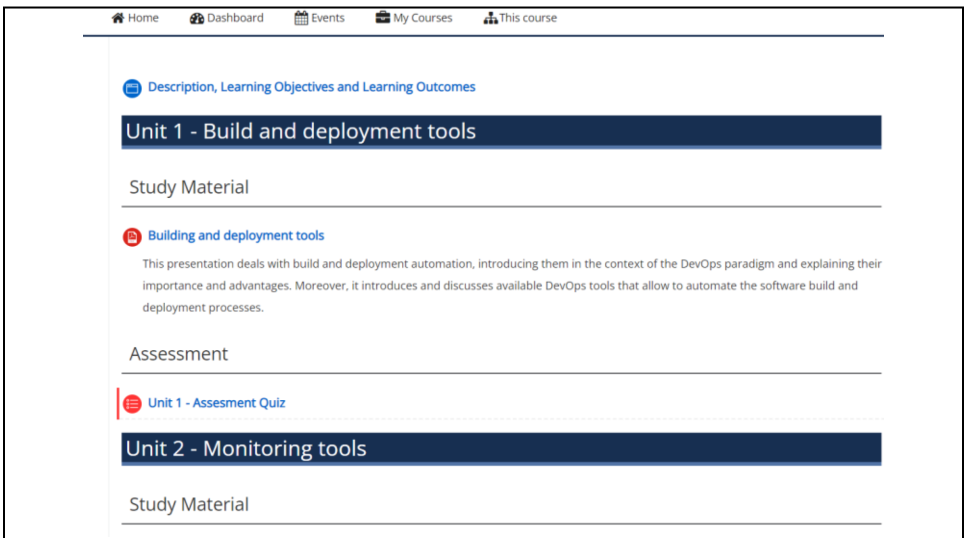

Fig. 4 Part of the Specialization course in Moodle

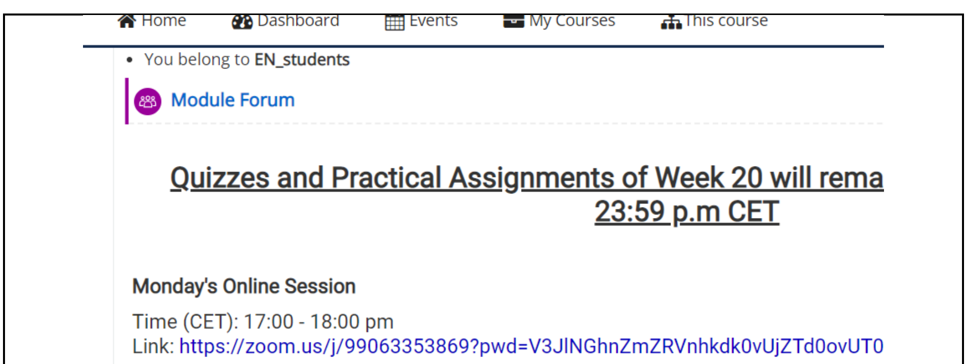

Fig. 5 Example of user support through forum and synchronous sessions

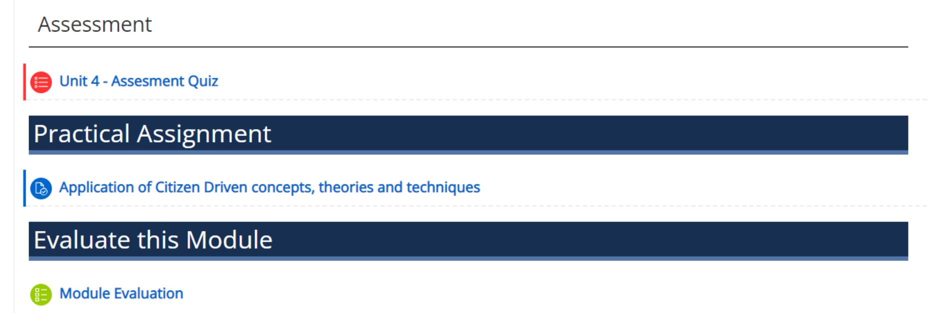

Fig. 6 Assessment activities

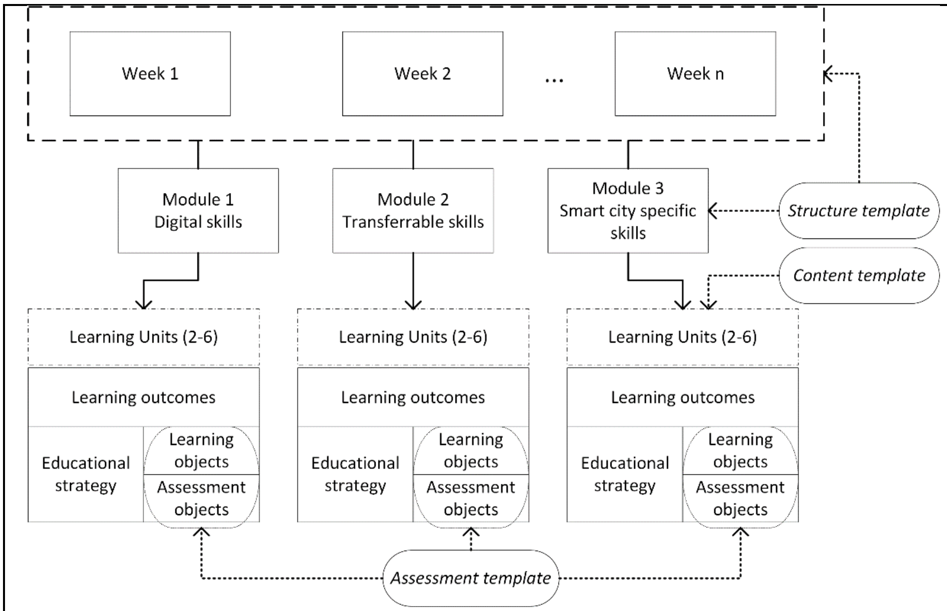

Fig. 7 Course structure with specific structural and content checkpoints

provider, a standardization organization and an IT company in the field of smart cities collaborated in the course design. Figure 7 depicts the organization of the course which consisted of 22-24 learning modules depending on the learning path. Each competency formed a learning module, which consisted of 2 to 6 units and each unit included learning and assessment material. Several templates were developed to maintain the metadata of the modules, units and educational material. These templates guided the gradual development and structuring of each module providing information on objectives, keywords, required workload, educational strategy and external resources and linking learning objects to learning outcomes.

Validation of the material and demonstration of the competencies

A panel of subject matter experts reviewed the content's scientific accuracy, pedagogical coherence, and technical excellence. The templates helped standardize the material and make the structure visible to all stakeholders. The structure itself established criteria for material release. Pilot runs were held even when the e-course were ready, to validate the design and the learning process. Learners evaluated the course using end-of-unit and course questionnaires. The learning process was also monitored via forums and log files to assist users and cope with unanticipated issues.

Assessment is a crucial part of any learning activity and in particular in CBL, as the results should be measurable. It is also required in the hierarchy of postsecondary outcomes model. Therefore, during the design of the learning objects, it was decided that for each competency there would be at least one collaborative small-scale project, an individual assignment and a quiz. These activities, once completed with a score greater than 70%, would indicate successful completion of learning modules and thus competencies' acquisition by the learners.

Course deployment and participants

The course ran during the first trimester of 2022 and was delivered via Moodle (see Figures 4, 5, 6). The learning and assessment material was administered in asynchronous, cohort-based learning mode. Learning material was provided in five languages namely English, Greek, German, Italian and French to facilitate the participation of a larger group of learners. A number of synchronous sessions during the course facilitated the collaboration of the learners and the communication between learners and trainers. Further, learners were supported by forums and email communication. Moodle provided a number of reports to monitor the engagement and progress of the learners. Activity completion conditions were applied to ensure the accomplishment of certain standards for each competency. E-learning specialists were responsible for the development of the course and domain experts oversaw the learning progress and assisted the trainees.

It was eventually attended by 178 participants. 36% were female, 64% male; 47% aged 35-54, 20% aged 18-24, 16% aged 30-34, 14% 25-29 and 3% more 55 and above; 45% possessed an MSc, 28% BSc, 16% high school degree, 9% vocational or professional degree and the rest had a PhD or they did not specify. 45% of the participants worked in the private sector, 22% was employed in the public sector, 13% in both sectors through contracts and 20% were currently unemployed or students. 51.68% chose the Smart City Planner path; 28.10% the Smart City IT Manager path; 20.22% the Smart City IT Officer path. These demographics are important as they indicate that there was a balanced distribution among educational and professional backgrounds with most of them seeking more advanced knowledge and skills through this education.

Evaluation method

To realize the potential of the course, we first administered a 20-question pre-test quiz on course-related topics. A similar examination was offered after the course. Both quizzes had closed-ended questions and covered the same concepts. The second one was a bit more technical though and thus more demanding. We sought to see whether there was a gain in knowledge after the participation in the topic.

Students were required to complete team and individual tasks and quizzes at the conclusion of each learning module, which assisted them in gaining practical experiences through the participation in these activities. Fulfilment of these activities was required for completing the course.

After the end of the specialization course, participants were asked to answer a semi-structured survey adapted from Dixson (2015), through which we aimed to assess the following dimensions:

a. the perceived relevance and quality of the course, and

b. the learning acquisition of the participants.

These two dimensions explore the three research objectives of the work, established earlier in the paper. The first dimension was assessed through questions Q1 to Q9, while the second through questions Q10 to Q15 of the survey shown in Table 1. Participants were asked to rate the survey items using a 5-point Likert scale, where each point of the scale stands for a specific level of agreement with the statements ranging from “strongly disagree” to “strongly agree”.

Table 1 Survey questionnaire

No.	Question	Type
Perceived relevance and quality of the course		
Q1	The course content was well structured, topics and subtopics were logically arranged in a predictable pattern	Likert scale
Q2	The overall objectives of the course were clearly stated	Likert scale
Q3	The overall objectives of the course were supported by the respective educational material	Likert scale
Q4	The content was presented in a clear and comprehensible manner	Likert scale
Q5	The assignments were immediately associated to the course contents	Likert scale
Q6	The course was engaging	Likert scale
Q7	I feel like I achieved my personal goals for this course	Likert scale
Q8	It is very likely to recommend this course e.g., to a colleague or friend	Likert scale
Q9	It is very likely to revisit the course materials in the future	Likert scale
Learning gain		
Q10	The course covered contemporary topics	Likert scale
Q11	Most of the presented material was new to me	Likert scale
Q12	The topics were relevant to my current work duties	Likert scale
Q13	I improved my knowledge on smart cities related topics	Likert scale
Q14	I improved my practical skills on SMART cities	Likert scale
Q15	The course helped me to acquire competencies which are practical and applicable to smart city jobs	Likert scale

These questions examine whether the competencies are applicable to their everyday duties, whether the course is engaging, and whether they would revisit or recommend the course to others. The responses to these statements are indicators of usefulness and the learning acquisition of the participants, as if the course is not engaging or not worth recommending and revisiting then the content does not have an added value for the participants. To explicitly rate the learning acquisition with respect to the specific competencies covered in the course, we also asked the participants to state whether their knowledge and skills have been improved.

Further, we asked the participants to point out the most positive point and the most negative point with respect to the e-course and to provide any other comment they would like to add freely. The last three free-text questions were voluntary.

Results

Completion rate

The course has been completed by 96 participants, which results in a 53.93% completion rate. This is approximately similar to all the different groups. The obligation to participate in all the activities (individual and team assignments) in conjunction with the high completion rate are supporting points towards our first research direction.

Pre- and post-tests

The second step of the evaluation methodology was to assess the results of the pre- and post-test. Table 2 presents some descriptive statistics of the results. We run an unpaired t-test and the difference in the two means is considered to be statistically significant ($p<0.0001$).

Survey

The questionnaire was completed by the 96 trainees who completed the e-course. The data were analyzed descriptively and explanatorily. We performed a reliability analysis using the SPSS statistical tool and found that Cronbach’s alpha is 0.794, which indicates a high level of internal consistency for our scale with this specific sample. To test the validity of our questionnaire we used the Pearson Product Moment Correlations using SPSS which correlates each answer score with the totally score. Based on the significant values obtained by the p-value, we concluded that all the questions are valid.

Table 2 Pre- and post-test statistics

	N	MEAN	SD
Pre-test	178	10.38	2.38
Post-test	96	14.82	2.01

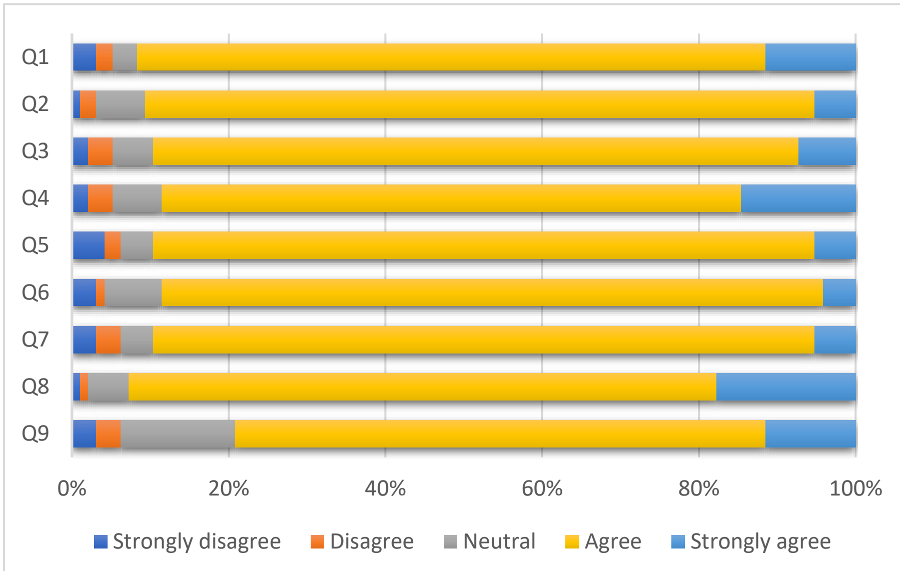

Fig. 8 Responses to questions associated to perceived relevance and quality of the training activity

As seen in Figure 8, most of the participants agreed or strongly agreed that the course structure, the objectives and the material were consistent and clearly presented. The assignments were aligned with the course objectives and overall, the course was engaging. A high percentage will probably recommend the course to a colleague or a friend and it is highly likely to revisit the material in the future which is important for the sustainability of the endeavor.

Figure 9 presents the responses of the participants with respect to the learning gain. The majority agreed or strongly agreed that they increased their knowledge, skills and competencies and that the learning materials were contemporary and new to them. In Q12 we have a detectable "disagree/strongly disagree" percentage, as a number of the participants are either unemployed or students, so the learning material is not immediately connected to their current duties. But, still more than 67% consider that the course topics are relevant to their current work duties.

The last set of questions related to the most positive and the most negative points of the course or any other comment the participants wished to add. As far as the most positive points, "team assignments", "contemporary topics", and "support" were the most recurring remarks. Some of the participants would like more time to complete the course, more external resources and a small number of the participants mentioned that the passing score should be lower. Most of the additional comments were positive "I am highly satisfied with the training", "It was a good online course", "I would be interested in participating in new learning activities", etc.

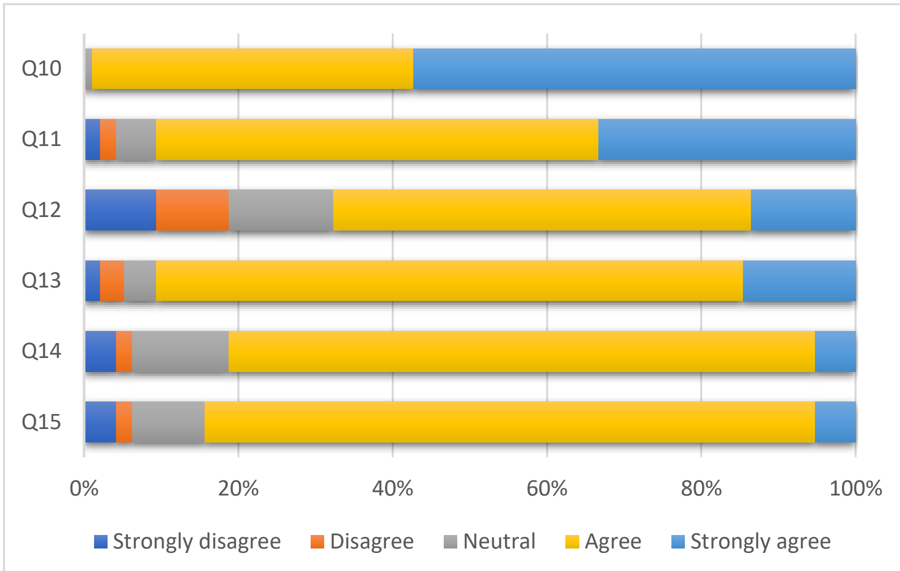

Fig. 9 Responses to questions associated to the perceived learning acquisition

Discussion

In the paper we discussed the methodology followed in a competency-based e-learning specialization course for smart cities. The training material covered competencies which concern technical topics for three job profiles identified in some of our previous works. The architectural design is based on specific templates and it separates the process of developing a course into concrete stages with specific checkpoints. Different types of proofs by scientific and technical reviewers ensure the validity of the content of the learning objects and the consistency of the structure of the course. We followed a 5-step methodology, i.e., recognition of the needs of the learners, identification of the competencies, establishment of the assessment mechanism, development and verification of the course's materials, evaluation of the course.

The course has been deployed with a 53.93% completion rate, which is considered to be quite high. We tested the knowledge of the participants using a pre- and post-test and we observed an improvement in their knowledge on the smart city topics. The 96 learners who completed the course, had also to complete an online questionnaire to assess the efficacy of the specialization course. Participants were supportive in the statements about the objectives of the course and the content. The majority agreed/strongly agreed that the course was well structured, with clear objectives supported by the respective content. The assessments helped the learners to gain a better understanding of the learning material.

Through the answers of the survey participants, that they achieved their personal goals, the course was engaging and they would probably revisit the learning material.

The second dimension examined through the questionnaire concerned the perceived learning acquisition which is the core of our work. The vast majority of the respondents "agreed/strongly agreed" that the course covered contemporary topics which were new to them. The respondents also verified that they improved their knowledge, skills and competencies on smart cities which is fundamental for our work. "Team assignments", "contemporary topics", and "support" were the three most positive points raised by the participants. The observations which concern the duration of the course, the additional resources and the passing score will be considered in newer deployments of the course.

The above findings support the research aims of our work. Indeed, we managed to develop a competency-based training program which would be helpful to the current and future employees of smart cities. This is verified by the responses to various questions, e.g., Q6 to Q12. The participants felt that the course was useful and it covered previously unknown to them topics yet relevant to their job duties. The second research aim is verified by 2 out of the 3 participants. We further looked into this question and the percentage is more than 80% among those who already work in some smart city sector. The last research aim is the most important one as the whole idea was to help the trainees to gain practical competencies. The results of the post-test, the responses to questions Q10 to Q15 and the positive comments on the free-text questions are strong supportive indicators towards the last research aim.

A central observation of our work is that the practical assignments (team or individual) are important if we need to equip students with applicable skills and to help them reinforce their competencies. This was observed through the responses of the trainees to the questionnaires but also throughout the duration of the course, based on the comments posted in the forum and on the discussions during the synchronous sessions. It is a more demanding approach for both the trainers and the trainees, than having close-ended questions, but it strengthens the learning process. Since CBL is an outcome-based approach to learning, being able to show tangible results through real-world assignments is important for any learning activity.

Conclusion

In the current paper we presented a competency-based specialization course for smart city employees. To help the trainees build their competencies we followed a structured and mixed approach where each competency was partitioned in learning units and each learning unit followed the nine steps of Gagne's instructional design theory. Assessment crossed all the phases from the development of the material which is assessed by domain experts, to the development of the course evaluated by technical reviewers to the deployment of the course were trainees had to participate into multiple assignments and quizzes. Regarding the efficacy of the developed course, responses of the participants to the evaluation survey was supportive towards our work, as they found the course relevant to the concept of smart cities, useful for their work duties, while participation in the course resulted in increased overall competency in all three smart city job profiles. We plan to have focused interviews in the next coming months to further realize the impact of our course to the job duties of the employees. The structured nature of the course allows for the integration of new topics once such a need arises.

Abbreviations

CBL: Competency-Based Learning; ICTs: Information and communication technologies; MOOC: Massive Open Online Course; NSPCBE: National Survey of Postsecondary Competency-Based Education.

Author's contributions

All authors have contributed equally to the development of the article.

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Funding

The work is partially supported by Erasmus+ project DevOps (601015-EPP-1-2018-1-EL-EPPKA2).

Availability of data and materials

Not applicable.

Declarations

Competing interests

The authors declare that they have no competing interests.

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Received: 11 October 2022 Accepted: 7 July 2023

Published online: 1 January 2024 (Online First: 31 July 2023)

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