

Summer school: a non-formal way to tackle education challenges

Olena Chernyshova¹, and Tetyana Tokmylenko²

¹ Independent researcher, 312, Gagaryn Ave., 61080, Kharkiv, Ukraine

² Kharkiv National Automobile and Highway University, 25,
Yaroslava Mudroho Str., 61002, Kharkiv, Ukraine
olena@tokmylenko.com, tetyana@tokmylenko.com

Abstract. The system of education is challenged by need to prepare a new generation of professionals who would not only master a field-required skill but also harness soft skill. The paper reviews definition and characteristics of formal, non-formal and informal education models and defines the possibilities to address the education challenges in combination of forms. The Summer school as a form of non-formal education is defined and proposed to fill the gap in formal education. The paper presents a framework of how to develop a curriculum for a summer school centered around a competency-based approach. The three key components — profile of participant, expected result, and real-life problem, form a set of skills and knowledge that define learning outcomes and shape the program. Finally, the paper reviews the case study of summer school hold in Kharkiv to demonstrate how the approach can be applied to practice. Summer school is a useful tool to establish and test new forms of education that contribute to learning process of both students and educators.

Keywords: lifelong learning, summer school, non-formal education, competency-based learning.

1 Introduction

No doubt that higher education system in Ukraine is being challenged. Fast growing technologies, globalisation of education opportunities, brain drain, integration with international market, it all requires the educational system to adapt or otherwise it will not be competitive at attracting students.

It should be noted that the traditional orientation toward professional specialization of personnel loses its relevance in many respects, since technological structures are developing so rapidly and abruptly that the potential of scientific information accumulated by a specialist during training is exhausted very quickly. The half-life of specialized engineering knowledge is now from 2 to 5 years [1].

According to a survey of chief human resources and strategy officers from leading global employers the main skills required from employees are:

- Complex Problem Solving
- Critical Thinking
- Creativity
- People Management
- Coordination with Others
- Emotional Intelligence
- Judgement and Decision Making
- Service Orientation
- Negotiation
- Cognitive Flexibility

All these skills are important without regard to the field and cannot be taught by a formal learning approach typical for classic education. Neither continuing education, nor individual work on oneself, nor retraining can compensate for this gap if the educational system does not change significantly towards the universalization of a specialist, fundamental training with general theoretical and humanitarian disciplines [2].

These changes have challenged traditional education models especially in emerging cross disciplinary professions, which resulted in active discussion of curricula development and transformations of program development where competencies and employability are emphasized in academia worldwide [3–5].

One of the possibilities to bridge the gap is to build a relationship between the formal and informal sectors. The non-formal education can provide access to up-to-date science and opportunities for self-directed education, the formal sector remains the core for science education [6].

The goal of this research is to define the possibilities to improve the quality of vocational training by integrating the capabilities of the non-formal sector into formal sector, particularly in a form of summer schools. The objectives of this paper are (1) to review a practical case of summer school as an example of short-term non-formal program to compensate the gap between theoretical and practical education and (2) to formulate the a framework for developing a curriculum for a short-term program in multidisciplinary studies related to transport planning.

The methodology is based on analysis of current state of higher education and features of non-formal education and modelling of integrated teaching product in a form of summer school. The paper discusses the key trends in Ukrainian education and the role of informal and non-formal education in

it. The authors provide the review of different educational approaches that could be used to improve the quality of education and define a summer school as a form of non-formal education. In the paper the authors propose the structure on how develop a curriculum for a summer school for students in transportation field and propose a case of how the approach can be applied to practice.

2 Key trends shaping Ukrainian educational system

The main purpose of vocational education is to train qualified specialists of the appropriate level, competitive in the labour market, competent, responsible, and advanced in one's field. Changes in the strategy and content of the professional education of future professionals should be planned in accordance with the functions of competencies in relation to different aspects of education: student's personality; one's knowledge, skills and abilities; the structure and content of education; and in relation to the types of activity.

In recent years, there has been a spread in non-formal education activities in Ukraine, increasing its impact on various social-age and professional groups, mostly affecting civic society education and personal development. Surveys of 1,036 respondents from all regions of Ukraine show that a significant number of people (71.4%) have already been participated in non-formal training. The main purposes of participating in non-formal education are personal development (74.2%); raising overall level of education and world outlook (72.5%); professional development (67.9%); and getting a new profession (12.7%) [7].

Another trend that affects the education system globally but also in Ukraine is a raise and active development of technology in education. The review of impact of innovative practices and technologies for higher education across the globe (Table 1) shows that there is a focus on multidisciplinary and cross-institutional collaboration, starting from redesign of learning spaces.

Higher education at the present stage is characterized by a decrease in traditional lectures in the direction of more active classes, in the direction of real-world cases and promotion of peers' interaction and interdisciplinary problem solving. Possibility to switch between specializations opened a possibility for multidisciplinary studies at the higher level of education, e. g. a geographer or sociologist can complete a Master's in Transportation sciences, which allows to apply more complex and specific research methods into a broader issues and also to develop cross-disciplinary research such as Transport behavior studies or Transport Ecology, etc.

Table 1. Key trends in adopting technology in higher education 2015–2018

Year	Key Trends Accelerating Technology Adoption in Higher Education		
	Short-Term Trends: Driving Ed Tech adoption in higher education for the next one to two years	Mid-Term Trends: Driving Ed Tech adoption in higher education for the next three to five years	Long-Term Trends: Driving Ed Tech adoption in higher education for five or more years
2015 [8]	Increasing Use of Blended Learning Redesigning Learning Spaces	Growing Focus on Measuring Learning Proliferation of Open Educational Resources	Advancing Cultures of Change and Innovation Increasing Cross-Institution Collaboration
2016 [9]	Growing Focus on Measuring Learning Increasing Use of Blended Learning Designs	Redesigning Learning Spaces Shift to Deeper Learning Approaches	Advancing Cultures of Innovation Rethinking How Institutions Work
2017 [10]	Blended Learning Designs Collaborative Learning	Growing Focus on Measuring Learning Redesigning Learning Spaces	Advancing Cultures of Innovation Deeper Learning Approaches
2018 [11]	Growing Focus on Measuring Learning Redesigning Learning Spaces	Proliferation of Open Educational Resources Rise of New Forms of Interdisciplinary Studies	Advancing Cultures of Innovation Cross-Institution & Cross-Sector Collaboration

At the same time apart from opportunities opened such trends require to rethink the role to educator and reorganize the program in order to make sure it is appropriate for the multidisciplinary and complex group of students. To be up to the task the educators are to leverage active learning methodologies such as project- and problem-based learning. This shift to student-centered learning requires instructors to act as guides and facilitators, which is typically considered as characteristic of non-formal education.

3 Summer school as a form of non-formal education

3.1 Review of educational models

Many modern education concepts are often perceiving education as the lifelong process, meaning that learning happens through a various situation throughout life, comparing to traditional concept where the education is

received through a course of formal academic education [12–15]. These concepts allow to implement the principles of a continuous education system that must be implemented in the process of designing educational programs to address the issues that arise at different periods of one's life. These principles include: a) progressiveness in the formation and enrichment of the creative potential of the individual; b) vertical and horizontal integrity of life educational process; c) integration of educational and practical activities; d) taking into account the peculiarities of the structure and content of human educational needs at different stages of one's life cycle; e) substantial continuity of the ascending degrees of educational levels; f) unity of vocational, general and humanitarian education; g) self-education in the periods between the stages of organized learning activity; h) integration of formal, non-formal and informal components of a continuous educational process.

Integration of last principle requires to distinguish between the three form of learning process, which is defined by the level to which the learning process is directed. The formal education is characterized by established curriculum, it is systematic and structured, methodologies are defined, and evaluation is conducted regularly according to defined criteria. A degree education from accredited institution is typical example of formal education. If the structure of education is rather flexible, allows for modification, focused on student, lacks evaluation at all or has a flexible form of evaluation this is non-formal education. Informal, or also known as incidental, education is learning that is intentional but not structured, it is rather included in one's routine and does not have a curriculum. Examples include self-directed learning, networking, coaching, mentoring, and performance planning [14, 15].

If formal education creates a “core knowledge”, then non-formal education rather improves it, deepening competence in areas of interest to students, generating sustainable motivation for learning and personal development, or generating skills that go beyond the goals of the formal education system (ability to cope with problems and stressful situations, the ability to think critically and participate in social processes, the ability to live in the conditions of diversity and dynamic changes in society, the ability to learn, etc.).

Non-formal education is based on three important principles that should be combined in each learning measure. These principles are:

- learning by doing, meaning to acquire different skills during practice;
- learning to interact, which involves learning to work in a team and

being encouraged to work with others;

- learning to learn, which involves acquiring the skills to search and process information, as well as the ability to analyze one's experience and learn from it.

Learning by doing is a viable approach to practical education and an important element of preparation. It involves engaging students in group situations to help each group member learn in the process of finding solutions to problems. Through this process, students raise awareness in their actions and develop new knowledge, attitudes, behaviors and skills to accept change and adjust their roles in new contexts.

Characteristics of learning by doing [16]:

- training is based on solving real problems;
- the training is of a mutual nature and takes place jointly with those who are interested in solving real problems;
- group members bear responsibility for solving the problems;
- group members are interested in taking action on the basis of decisions made, not just in analysing and getting advice;
- situated learning.

Situated learning is an approach that deserves attention. In a situational approach to learning, knowledge and skills are mastered in contexts that meet the conditions in which knowledge will be applied in real life situations. This strategy is based on the premise that knowledge is not independent, but fundamentally part of the activity, context and culture in which it is acquired. Situated learning is important in a particular social context in which learning takes place, which gives preference to the development of knowledge and offers the student the opportunity to apply this knowledge at a new level and in new situations. Situated learning, as well as learning by doing, is more oriented towards behavior change as a result of reflecting on the experience of activity.

Incident learning is another way of learning to do hands-on work that is less about reflection. Random training is unintentional and does not imply control of development. It is not reflection-based, but simply part of any meaningful activity. While it might not be planned or evaluated it still can happen during formal and non-formal education process.

Each of the learning approached has common features and attributes with one another. For example, they all involve students in experiential learning. The gap between student and expert (teacher) is disappearing, as anyone can be an expert in some part of the cooperation. Often, team

learning takes place through communication and collaboration between individual participants and groups, and benefits everyone.

Conditions that increase learning effectiveness, and which are common to the three approaches, are as follows:

1. Proactivity when a student takes responsibility and directs his or her learning. It is determined by autonomy and responsibility.
2. Critical thinking, through which students create and carry out the selection of formalized norms, values, and working hypotheses that allow to obtain the necessary results.
3. A creative approach that allows you to see the situation from different positions and points of view.

While the approached presented here are typical for non-formal education this educational activity can be structured, allowing for flexibility it still may have a learning purpose, timetables, infrastructure support and be planned [17]. Non-formal education can be “embedded” into the formal system, complementing it and working with it in a certain synergy.

3.2 Definition of Summer school as a form of non-formal education

In order to improve the quality of competence-based life-long learning European commission recommends combining different forms of formal and non-formal education models. One of the forms of such combination might be a Summer school or Summer university. Originally Summer schools started as learning activity during a summer break to narrow the gap in education due to the lack of learning activities for children at summertime [18]. Participation in summer schools has been shown to have substantial beneficial effects on educational progress [19].

In North America Summer schools were adopted in colleges and Universities to allow students to receive remediation or advancement credits during summer break. Remediation summer schools are used to receive credits that were missed or failed. While the advancement summer schools are used to attend classes and accelerate progress towards degree or lessen the load of courses during the regular school year. Many universities offer short-term summer courses to attract both local and international students, and these programs are often surrounded by social activities.

Outside North America the term has a wider meaning. Summer school may function outside universities as well, it can be targeted at people of different age and degree level as well as various fields. Summer schools can

also provide students or professionals of different field with educational experiences that would not be available to them within their normal schooling [20].

While term “Summer school” and the history of its establishment clear states the particular time period when it is supposed to be hold, eventually it transformed into rather universal term for a short-term educational program not required by a specific degree-program, starting at any month of the year, however, often associated with break period at formal education institutions.

In this paper we are using Summer school term to describe an education activity that has following characteristics:

- Duration of school is not less than three days, so it allows the transformative educational process as well as allows to have a minimum number of theoretical and practical hours. While the maximum duration of school may vary it is assumed that the school will be no longer than three weeks, otherwise the nature of the program would need to differ significantly.
- The program is not associated or required for any degree program, and while it can allow to collect the credits towards a degree program it cannot be required to pursue a degree.
- The program has a clear objective and learning outcomes, as well as necessary practical case to be resolved as part of learning process.
- The program intensively exploits principles of formal and non-formal education in order to achieve the results of the school, particularly rethinking the classic role of educator and promoting facilitation principles rather than instructing.

The question that arises whether a form of summer school can be used for the preparation of transport professionals. The empirical data shows that there is an evidence that short-term educational programs such as Summer schools are getting more popular, including schools in engineering, economics and other social studies. Ukraine is not an exception, schools in history, business, and linguistics are organized in Kyiv-Mohyla Academy, Karazin Kharkiv National University, The Ukrainian Catholic University, etc.

Based on database [21], originally founded by Utrecht Summer School, it is possible to analyse the key trends of Summer Schools in Europe. Figure 1 shows 7582 courses held in 2011–2019 and planned in 2020 distributed by the field.

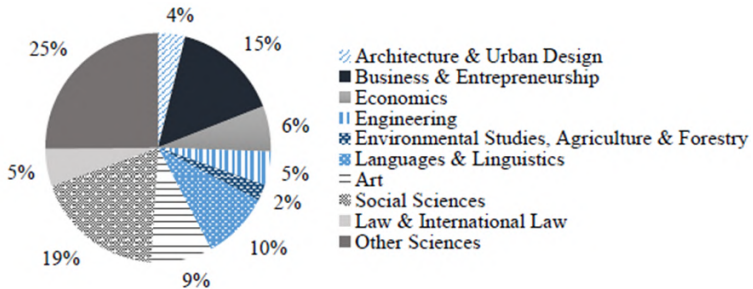


Fig. 1. Distribution of summer schools by the field
(self-prepared based on [21])

While courses in business and entrepreneurship as well as languages and linguistic are the most numerous schools registered in the database (Fig. 1), schools in engineering have the sharpest growth rate (Table 2). It is also important to notice the tendency of diversification of the course subjects. Depending on specialisation summer school for transport professionals can be categorised as engineering, economics and/or urban studies.

Table 2. Growth rate by the field of registered course

Year	Engineering	Economics	Architecture & Urban Design	Business & Entrepreneurship	Environmental Studies, Agriculture & Forestry	Languages & Linguistics
2015	1,000	1,630	1,067	1,009	1,364	0,851
2016	2,053	1,295	1,000	1,000	1,400	2,079
2017	0,923	1,158	1,719	1,147	1,238	0,565
2018	1,667	1,045	0,727	0,977	1,038	1,405
2019	2,467	1,565	1,800	2,423	1,667	1,942
T'	1,508	1,320	1,191	1,223	1,325	1,222

After the review of world practice of summers schools the authors came to conclusion that this form can be used for engineering and

cross-disciplinary education of transport professionals. However, the main question is how to develop the curriculum, which will address the challenge of applicability of knowledge and competencies and employability of participants.

3.3 Curriculum development framework

According to [3] the curriculum development should start with identification of the inner structure of the elements and their relations. Review of literature in the field of multidisciplinary field in planning shows that formulating curriculum for planning degree has to balance vocationally oriented skills and critical holistic knowledge [4]. Combining the characteristics of summer school with the principles of competency-based learning allows the authors to propose a framework for developing a curriculum for a short-term program in transport studies in a form of a block-scheme (Fig. 2).

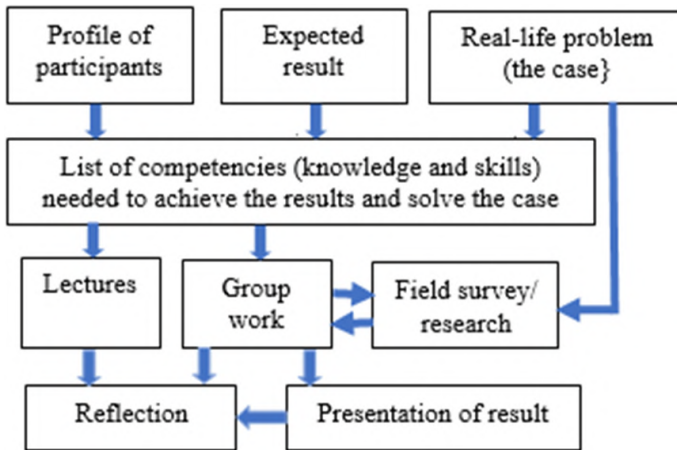


Fig. 2. The structure of summer school program development process

The three key components that define the whole program are profile of participants (whom do we want to educate), expected results (what we want to achieve as result of learning process), and the case (what kind of real-life problem the participants will solve over the course). These three elements help to define a start point and an end point of education and the gap should be filled within a summer school. Change in one of the components would require to completely review or at least adapt the program. For example, a summer school for undergraduate level students, who needs

to be introduced to sustainability principles, will be significant different from a summer school targeted at professional engineers seeking to receive practical skills in conducting transport impact study.

However, for all different types of participants, even though the content of material and level of advancement should differ there must combination of lectures, group work and field work. The lectures are required to provide all participants with some guiding knowledge applicable to the task but also wider that solution to specific problem (the case). The lectures are a form of providing the basic knowledge that can be tested during group work and field survey. The group work is a form where the focus shifts from educator to learners. The role of educator shifts to facilitation with minimum interference. This is where participants can learn such skills as complex problem solving, creativity, people management, coordination with others, judgement and decision making, etc. A reflection is an important element of the program, this is what makes it a situated rather incident learning. The group reflection is moderated and helps participants to convert their experience into learning.

In order to illustrate how the Summer school can be used for educating new generation of transport professionals we would like to review a case presented below.

4 Case study — International Summer School on Sustainable Mobility “Green corridors of Kharkiv” 2019

To illustrate how the Summer school can address the challenges of modern technical education we would like to review the case of the International School on Sustainable Mobility “Green corridors of Kharkiv” organized in partnership between Kharkiv National Automobile and Highway University (KhNAHU) and Technical University of Dresden (TUD) on 15–19th of May 2019.

The school was organized for the third time, however, for the first time it was meant to be interdisciplinary. The applications were accepted from students and young professionals in the field of transport technologies, civil engineering, architecture, sociology, geography, environmental studies and other relevant fields.

The expected key results of the school were that students would learn about the principles of sustainable urban development, methods and tools for assessing environmental sustainability and measures for urban planning in order to improve ecological sustainability. All participants were split into three groups each of which was assigned to research and develop

recommendations for green infrastructure (greenway) along the segment of Lopan river. Although the research area was defined the same for everyone, each group of students had a different focus based on three pillars of sustainability: ecological, economical, or social perspective.

The learning program was organized in four thematic blocks:

1. lecture or theoretical learning activity;
2. practical learning activity, including field trip and group work;
3. break, meals or networking activity;
4. general plenaries, including icebreakers, expectations setting and reflection sessions.

The total duration of school was four days with each day of the school consisted of 10 hours of learning experience.

Table 3. Key components of curriculum

Key component	Definition
Profile of participants	Students of 4–6 years of studies and graduates up to 2 years after graduation in the field of transport technologies, civil engineering, architecture, sociology, geography, environmental studies and other relevant fields.
Expected results	Students will learn about the principles of sustainable urban development, methods and tools for assessing environmental sustainability and measures for urban planning in order to improve ecological sustainability.
Real-life problem (the case)	Infrastructure improvements in the city of Kharkiv show asphalt and concrete are preferred for reconstructions of the public space, that in the end results into lack of green space in the city but also long-term environmental problems such as soil erosion, higher temperature of air, lack of access for animal life, etc. Land around rivers in the city provide an opportunity for development of green-corridors but have to be reviewed from perspective of ecological, economic and social sustainability.

As result of matching key components and key competencies required to resolve the proposed case the learning program included theoretical, yet very interactive, (Table 4) and practical program. The research

part included mapping, development of the research plan, conducting interviews, conducting measurements (pollution, temperature, car traffic counts, pedestrian traffic counts) and processing the results for the analysis.

Presentations of the results were conducted at the last day of the school by each group of participants in English language. The recommended outline of the presentation was: definition of problem, the results of the field survey (goal of the field trip, methods and results of the fieldtrip), and measures proposed to tackle the problem.

Table 4. Detailed list of units

Unit	Hours
Sustainable mobility. More is better?	1.5
Benefits of green infrastructure	1.0
Noise pollution from transport	1.0
Chemical pollution from transport	1.0
Travel behaviour theory and practice	1.0
The Psychology behind Green Corridors	1.0
Sustainable Transportation Planning	1.0
Active Mobility and green infrastructure	1.0
Pursuing international carieer in transport	1.0

The reflection was provided in a form of daily half an hour session where the moderator would allow student to reflect on their experience by answering to the questions: “what I learned today?”, “what do I take with me from today into tomorrow?”, “what would I do differently tomorrow?”. The questions were answered in private with a possibility to share with a group. The students could also raise a question related to program that they have left, and the question would be covered immediately or the next day at the morning plenary.

5 Discussion

Considering that the main goal is to bridge the gap of relevancy formal scientific education and employability of the students, the most relevant evaluation of the effectiveness of the proposed learning activity would be further professional success after completion of the course. Such evaluation has not been conducted to date since most of the school participants continue graduate studies (master’s and PhD) in their home Universities.

To conduct the evaluation whether proposed program compliment formal education provided to same target group as participants, the authors compared the curriculum of the summer school reviewed in the case study and curriculum of the bachelor's degree of specialty 275.03 Transport technologies on Road Transport.

The distribution of the types of learning activities during International school on sustainable mobility is presented on fig. 3 shows a significant focus on group work and field activities.

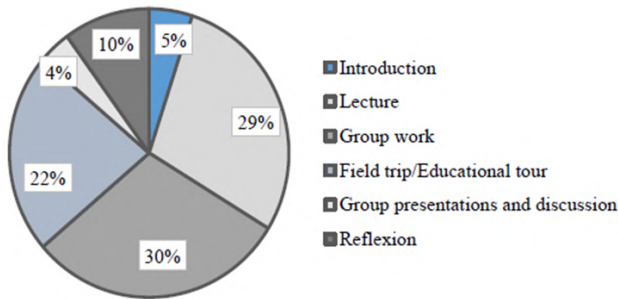


Fig. 3. Distribution of types of learning activities during International school on sustainable mobility “Green corridors of Kharkiv” 2019 (estimated from program based on hours allocated)

If compared to the curriculum of the bachelor's degree of a specialty 275.03 Transport technologies on Road Transport (Fig. 4) it is possible to notice that the normalized time of independent work of the student exceeds the classroom load. The independent work of student includes preparation of course paper; internship or vocational training; preparation for lectures, seminars, laboratory works, tests, exams; preparation of research papers, etc. It is important to note that 57% of time student is expected to work independently with some level of supervision from educator. When in fact interacting with peers might be more important at the workplace, contributing to competencies such as ‘coordinating with others’. At the same time formal education model provides more time independent work and relatively less time for hands-on training.

While formal education model is more applicable to obtain fundamental knowledge, the short-term training in a form of summer school allows students to simulate the real-life work experience, where the instructions for solutions are limited and there is a necessity to use previously obtained knowledge, negotiate with a team on making decision and contribute to the common result.

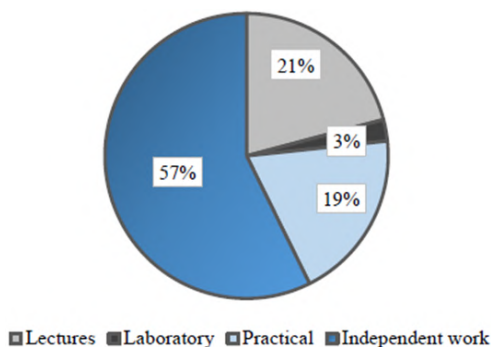


Fig. 4. Distribution of types of learning activities

Summer school is also a tool to train not only students but also the educators. The format of dynamic and intense group work requires the presence of facilitator to ensure that the group is following the pace and is likely to produce the expected results within a given timeframe. At the same time the nature of highly independent work of non-formal education requires the educator to shift from the role of unquestionable source of knowledge into the role of facilitator or rather an optional source of support. It allows the educator to question the methods and conventional approaches together with students, since the responsibility for the outcome is shared between participants. This is particularly important considering the dynamic of processes and how fast the knowledge is updated in the modern world. This feature of non-formal education can be useful to test ideas and approaches to further implement them into formal education curriculum.

The last but not the least the participants present their result to each other and a wider audience and there is no one authority that evaluate the results and “holds the knowledge” comparing to the evaluation methods (e. g. exam) in formal education. This allows participants to have a higher level of ownership for the result since they are allowed to have an opinion that might be unique and different from the one of superior.

Summer school allows students to receive knowledge that they can immediately apply. This allows to include learning-by-doing principle which is at the same time is planned and facilitated by more experienced professionals. It is also a good form to learn on how to work in multidisciplinary teams and allows to explore new fields before going into the degree program.

Even though, quantitative analysis of the effectiveness of the school has not been conducted yet, qualitative analysis shows that graduates of the

international summer school show above average academic and professional achievements. Several students continued education in Poland, Italy or Germany in the field of transport planning, some started employment or conducted internships in international and Ukrainian professional organizations (Dornier Consulting, A+S, USA Logistics and Transportation, Lvivelectrotrans, Institute for renewable energy of Ukraine, etc.), others were recognized at the science competitions and show other professional achievements.

6 Conclusions

Professional job market requires that the young professionals should be more flexible, learn fast, communicate efficiently and collaborate with others including peers from different fields. There is no doubt that in order to prepare such professionals the education system must be flexible itself.

In this paper the authors reviewed the capabilities of the non-formal education that can be used to bridge the gap between the formal education and dynamic real-world practice required for successful carrier in the field. The paper presents a framework to develop curriculum for a short-term program, such as a summer school in transport studies but can be adopted to other multidisciplinary programs. The framework consists of the inner structure of the elements and their relations. The basis for the curriculum is formed by three key elements of vocational education: profile of participant, expected result, and the case.

The proposed framework is then presented and tested in the case study, which shows that it can be successfully used for curriculum development and can be used to contribute to the professional education provided by formal education.

The analysis presented in the discussion section shows that summer schools can be used to improve the quality of vocational training. Conducting summer school along with classic education may be a good form of transformation for education system as well as platform to test new educational concepts or courses. However, the authors believe that non-formal education is rather a complimentary form to more fundamental scientific education with a more flexible structure and holistic approach. For further research it would be interesting to introduce the indicators to evaluate efficiency for the summer school, especially in a long-term perspective following several years after school completion.

The Summer School was funded by ERASMUS program of partnership between Kharkiv National Automobile and Highway University and

Technical University of Dresden and was supported by NGO “EcoAction”. We would like to thank our colleagues for their professionalism at teaching and facilitating the school: Angela Francke, Thilo Becker, Sven Fröhlich, Lisa-Marie Schaefer, Oleksandr Kolii, Hennadiy Pitytsya.

References

1. The Future of Jobs Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution: Global Challenge Insight Report by the World Economic Forum. http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf (2016). Accessed 21 October 2019
2. Dubaseniuk, O. A.: Rozvytok vyshchoi osvity: tendentsii ta perspektyvy. Paper presented at the conference Liudynotsentryzm yak osnova humanitarnoi polityky Ukrainy: osvita, polityka, ekonomika, kultura, IOD Natsionalna akademiia pedahohichnykh nauk Ukrainy, Kyiv, 22 February 2011
3. Schlingensiepen, J.: Competence driven methodology for curriculum development based on requirement engineering. *Procedia — Social and Behavioral Sciences* **141**, 1203–1207 (2014)
4. Dowling, R., Ruming, K.: Synergies between geography, planning and vocationalism in curriculum development and implementation. *Journal of Geography in Higher Education* **37** (2), 204–219 (2013)
5. Handy, S., Weston, L., Song, J., Lane, K.: Education of Transportation Planning Professionals. *Transportation Research Record: Journal of the Transportation Research Board* **1812**, 151–160 (2002)
6. Stocklmayer, S., Rennie, L., Gilbert, J. K.: The roles of the formal and informal sectors in the provision of effective science education. *Studies in Science Education* **46**, 1–44 (2010). doi:10.1080/03057260903562284
7. Moskalenko, L. M.: Tendentsii rozvytku neformalnoi osvity v Ukraini (za rezultatsamy sotsiolohichnoho doslidzhennia). *Visnyk Lviv. Univ., Ser. Sociol.* **12**, 212–220 (2018)
8. NMC Horizon Report 2015: Higher Education Edition. <https://files.eric.ed.gov/fulltext/ED559357.pdf> (2016). Accessed 21 October 2019
9. NMC Horizon Report 2016: Higher Education Edition. <https://www.sconul.ac.uk/sites/default/files/documents/2016-nmc-horizon-report-he-EN-1.pdf> (2017). Accessed 21 Oct 2019

10. NMC Horizon Report 2017: Higher Education Edition. <https://www.sconul.ac.uk/sites/default/files/documents/2017-nmc-horizon-report-he-EN.pdf> (2018). Accessed 21 Oct 2019
11. NMC Horizon Report Preview 2018: Higher Education Edition. http://ppgtic.paginas.ufsc.br/files/2018/09/ok_Horizon-2018.pdf (2019). Accessed 21 Oct 2019
12. Vision 2020. Excellence with Equity. Framingham Public Schools. <https://www.jefferson.kyschools.us/sites/default/files/Vision-2020-Brochure.pdf> (2014). Accessed 23 Oct 2019
13. Sisserson K., Manning, C. K.: Authentic Intellectual Achievement in writing. *The English Journal* **91**, 63–69 (2002)
14. Dib, C. Z.: Formal, non-formal and informal education: concepts/applicability. *AIP Conference Proceedings* **173**, 300 (1988). doi: 10.1063/1.37526
15. Marsick, V. J., Watkins, K. E.: Informal and incidental learning. *New directions for adult and continuing education* **89**, 25–34 (2001)
16. DuFour, R., DuFour, Reb., Eaker, R., Many, T. W., Mattos, M.: *Learning by Doing: A Handbook for Professional Learning Communities at Work*, 3rd edn. Solution Tree, Bloomington (2016)
17. Tokmylenko, T. T.: Vykorystannia pryntsyypiv neformalnoi osvity v protsesi navchannia studentiv. Paper presented at the 22nd international conference Upravlinnia yakistiu pidhotovky fakhivtsiv, Odessa State Academy of Civil Engineering and Architecture, Odesa, 20–21 April 2017
18. Cammarota, G., Stoops, J. A., Johnson, F. R.: *Extending the school year*. Association for Supervision and Curriculum Development, Washington (1961)
19. Chmelynski, C.: Summer School for Meeting Higher Standards. *The Education Digest* **63** (9), 47–50 (1998)
20. Crăciun, D., Bunoiiu, M.: Learning science outside the classroom: A summer school experience. *AIP Conference Proceedings* **2071**, 050002 (2019). doi: 10.1063/1.5090086
21. Summer Schools in Europe. <https://www.summerschoolsineurope.eu> (2019). Accessed 25 Oct 2019