

# Information System for Personalized Spaced e-Learning

Janis KAPENIEKS Sr., Janis KAPENIEKS Jr.

Distance Education Study Centre, Riga Technical University  
1 Kronvalda Blvd., Riga LV-1010, Latvia

[janis.kapenieks@gmail.com](mailto:janis.kapenieks@gmail.com), [jkapenieks@gmail.com](mailto:jkapenieks@gmail.com)

**Abstract:** Spaced e-learning is one of the opportunities to implement the findings of neuroscience, psychology and cognitive sciences to raise the effectiveness of e-learning. The spaced learning method is based upon the positive effects gained from the rehearsal of learning content after several repetitions. A mandatory requirement is the “disconnection” of the mind from learning content during short spaces between repetitions and the delivery of learning content in different forms for repeating. The objective of the transdisciplinary research is to create and validate an advanced information system for an innovative spaced e-learning methodology. Research shows that personalization of the content of spaces in accordance with the individual interests of learners is a useful tool for the improvement of the acquisition of knowledge and skills. The information system created in the project could be adopted for different e-learning environments.

**Keywords:** e-learning, spaced learning, information system, personalization.

## 1. Introduction

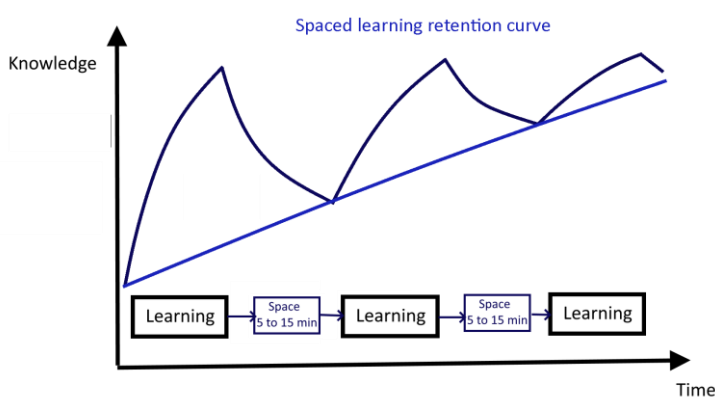
The latest developments of educational needs require essential changes in the design and content of learning management systems (LMS). The dominance of information technology, which has increased during COVID19, has already led to various changes in the pedagogical process. Spaced learning is one of the methods for improvement of the acquisition of new knowledge and skills in the digital age, requiring a new approach to the content and design of the e-learning environment.

The objective of the transdisciplinary research is the creation and validation of the information system for the implementation of the innovative spaced e-learning methodology. Improving e-learning effectiveness and improving the acquisition and retention of the learning material is the main purpose of the current study. Research includes design of technological solution to achieve a pedagogical effect for

improvement of knowledge acquisition and validation of the created technology and methodology in the Living Lab.

The spaced learning approach is based on the repetition of the learning content in different forms of delivery, divided with short intervals of between five to twenty minutes. The first research on the method was published by psychologist Hermann Ebbinghaus in 1885 in the book “Über das Gedächtnis. Untersuchungen zur experimentellen Psychologie” (“Memory: A Contribution to Experimental Psychology”). M. Versteeg et al. (Versteeg et al., 2020) identified 74 definitions of the spaced learning, based on educational activities, timing, structure, repetition or educational tool. Compilation of definitions is proposed by M. Versteeg:

*“Spaced learning involves [specified] educational encounters that are devoted to the same [specified] material, and distributed over a [specified] number of periods separated by a [specified] interstudy interval, with a [specified] learning outcome after a [specified] retention interval.”*



**Figure 1:** Graphic interpretation of the retention by spaced learning.

Authors illustration in accordance with Ebbinghaus (Ebbinghaus, 2013), Paul (Paul, 2014), Schimanke (Schimanke et al., 2016).

S. K. Carpenter’s and co-author’s research shows that the rehearsal of information with long spaces is more effective for retention of information in the long-term memory (Carpenter et al., 2012). Several authors emphasize, that spaced learning with long spaces is more suitable for the face-to-face learning (Kahana and Howard, 2005) (Versteeg et al., 2020) or delivery of information by e-mail (Kerfoot et al., 2010; Shaw et al., 2011). Figure 1 shows how the spaced learning method affects the acquisition of knowledge. After each repetition of knowledge, if this is done after a short break, more and more information is retained in the long-term memory.

## 2. Research method

The following stages of research were carried out:

- Justification of the spaced learning method from transdisciplinary neuroscience, cognitive sciences and psychology research by analysis of the previous research, emphasizing the short-spaced approach used in e-learning.
- The design of the first prototype of the spaced e-learning LMS in the OpenEdX MOOC type environment.
- An analysis of the outcomes from the implementation of the first prototype of the spaced e-learning LMS in the master level courses for “Natural Science Modelling” and “E-pedagogy” in the Riga Technical University. Big data from logfiles, students’ assessments and surveys were used for the decision on the most effective design and content of spaced e-learning information system.
- Creation and implementation in practice of the advanced spaced e-learning information system, based on Google applications and Moodle LMS for personalized content of spaces between repetitions of the learning content.
- Implementation of the TELECI method of data analysis and interpretation from logfiles for the evaluation of the appropriateness of the spaced e-learning learning process to the needs of learners and the learning objectives. The TELECI method has been created by the researchers of the Distance Education Study Centre of the Riga Technical University.

Spaced e-learning information system Living Lab is created in the Moodle learning management system (LMS).

## 3. Content personalization options in Moodle LMS

Moodle LMS learning content pages are rendered by Moodle LMS using data stored in the Moodle database. The content of the page requested is delivered to the web browser upon the content page request. The Moodle LMS content storage and delivery approach provides limited options for content personalization. The following personalization tools without using any plugin or external tool are currently available on Moodle LMS:

- 1) Branched lessons:  
Moodle lesson as a built-in activity plugin for learning content creation. Plugin provides a list of lesson elements for building a lesson. A content page, a question page and a cluster of question pages are included (WEB, b). Tools for creation of the sequence or branched structure of the content and question pages are provided. The sequence of the content pages can be adjusted upon the student’s responses in the question pages, providing personalization of the learning experience opportunity through adaptation of the content based upon the student’s knowledge level.
- 2) Quiz User Settings Overrides:  
Allows a list of individual parameters to be specified for a quiz. Includes settings such as: quiz time limit, number of attempts permitted, open and close time (WEB, f).

3) Access restrictions:

This feature enables the content creator to restrict access to Moodle activities, content according to conditions specified. The conditions can be date, student group id, grade, etc. (WEB, g) Allows the creation of multiple content/activities assigned to specific student groups and/or based on student's level of knowledge.

Moodle LMS external plugins provide functionalities which support personalized learning experiences. Most of them provide conditional availability or restriction rules, allowing to define which content is shown/hidden based upon pre-defined conditions. The external plugins are available from the Moodle plugins directory (Web, a). Two of them are listed below:

- 1) Moodle plugin *Restriction by single quiz question*. Using the Moodle LMS conditional availability rule plugin, it is possible to show or hide a resource, based on the state of one particular question in a quiz. The plugin provides the possibility to show a specific help information for the appropriate question (WEB, h).
- 2) Moodle plugin *FilterCodes* (WEB, c) provides customization and personalization options for the Moodle LMS site and course content using predefined text tags. This allows the Moodle content creator to insert specific values from user profile data such as first name, last name, country, etc., providing learning content personalization, limited to personalized welcome messages.

The personalized learning experience tools and plugins described above provide limited personalization options for the spaced learning approach. The "Restrict Access" feature could be used for providing the required functionality. It does however, require extra manual work and scalability options are limited for a large number of students. The Moodle LMS *FilterCodes* plugin provides useful features that can be used to enrich the Personalized learning experience. It is used as the spaced learning content personalization tool.

## 4. Process of the research

### 4.1. Educational encounters (learning content)

Delivery of the information in the first prototype ("Natural Science Modelling" and "E-pedagogy" master level courses) and in the advanced spaced e-learning information system ("Business fundamentals" bachelor level course) was in the form of text, video, interactive simulations and provocative questions. Such types of delivered information are built upon the previously learned knowledge and experience, leading to the active recall of the knowledge (Pappas, 2016) and motivating to the active application of knowledge (Prasad and Omer, 2019). Each time the amount of teaching material was set

at 10-25 minutes. Acquisition of the knowledge was based upon the constructivism epistemological approach (Bates, 2019).

#### **4.2. Interstudy intervals (spaces)**

Length of interstudy intervals was selected in accordance with the cognitive science research of Kelley and Watson (Kelley and Watson, 2013) and spaced e-learning approach pattern, proposed by Klemm (Klemm, 2012) and Pappas (Pappas, 2016). Design of the spaces is related to the technological requirements of the LMS EdX and Moodle. It is important that during the short spaces between repetitions that the brain of learner is “disconnected” from the learning content. The content and form of retrieved information during the space is linked to other issues that did not impose a heavy intellectual burden. In some cases, it may be indirectly related to the subject matter. Content of spaces is YouTube music, a video about attractive adventures or events, a beautiful nature video. In some cases, it is easy-to-understand additional course material video or interactivities. The objective of the transdisciplinary research is to find the most effective solutions for spaced learning in the e-learning environment and to create an information system for the implementation of spaced e-learning in the learning management system (LMS). The method is based on short breaks (spaces) between repetitions acquiring the learning content in the e-environment. During breaks, students disconnect from the learning by watching engaging alternative content. During the research, the first prototype of spaced e-learning solution was implemented in the LMS OpenEdX and brought into action with bachelor level students. Experience from the first prototype showed the effectiveness of the method and advantages of personalization of the content of spaces. Research showed the need to take personal interests into account for spaces’ content personalization to motivate students to use the method in the learning process. In the light of the data obtained, an information system (IS) for the personalization of the method was developed for use in several kinds of LMS (Kapenieks and Kapenieks, 2021).

In the latest version of the prototype, students created engaging material in accordance with their interests in the form of video, Prezi or Google slides presentations. The advanced spaced e-learning system in the Moodle LMS provided personalization of the educator’s or learner’s created spaces’ content to the individual interests of the learner. Research from the prototype led to the conclusion that personalization of the spaces’ content could significantly improve the efficiency of the method. Personalization is implemented in the advanced information system, validated in the Living lab as the spaced learning Business e-course in the Moodle LMS.

#### **5. Living Lab participants**

First prototype of the spaced e-learning LMS was implemented in the master level courses “Natural Science Modelling” and “E-pedagogy” in the Riga Technical

University for students of Digital Humanities program in the first and second semesters of 2018/2019 and 2019/2020 academic years. Spaced e-learning was implemented in the MOOC type e-learning environment OpenEdX design of Natural Science Modeling and E-pedagogy courses. The study course “Natural Science Modeling” was acquired by 14 and 20 students, respectively, and the study course “E-pedagogy” was acquired by 13 and 17 students, respectively. Conclusions from the implementation of the prototype (Kapenieks and Kapenieks, 2020) led to the determination of basic principles for the design of an advanced information system in the Moodle LMS. Basic principles included:

- The use of learner-made engaging materials in accordance with their individual interests,
- Personalization of the spaces’ content to the individual interests of each learner.

The advanced information system is implemented in the Business course for continuing education, corresponding to three ECTS. 12 participants of the Business course were involved in the Living Lab for validation of the IS. The age of the participants of the Living Lab was between 30 and 60, all of them were seriously affected by the COVID 19 pandemic restrictions. Several learners were planning to start their own business and develop a business plan for their idea during the course.

Learning outcomes are analysed by the learners’ behaviour data from logfiles, assessments and the TELECI method, created by Riga Technical university researchers (Kapenieks and Daugule, 2020).

## 6. Design of the IS for spaced e-learning

### 6.1. Structure of the IS

The IS for the spaced e-learning in the Moodle LMS consists of two sections (Fig. 2):

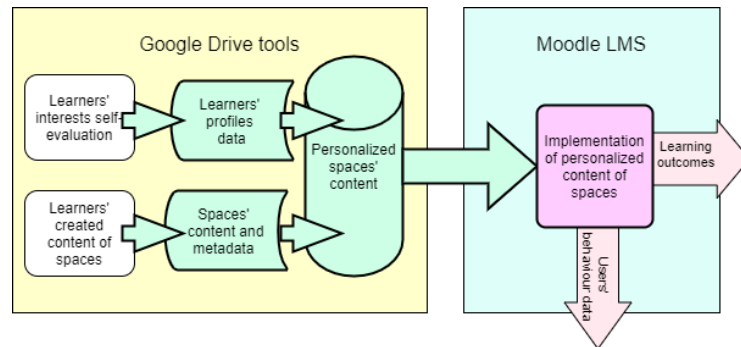
1. Google Drive:
  - Dataset on the individual interests of learners from the poll in the Google form, characterized by the rated (from 1 to 5) keywords,
  - Database of the learners’ created content of spaces, characterized by the same rated (from 1 to 5) keywords,
  - Dataset determining the compliance of the materials, prepared by the learners, with the interests of each student in descending order. The relevance of a particular material (identified by  $i$ ) to the interests of each student is characterized by coefficient  $C_s$  (Kapenieks and Kapenieks, 2021)

$$C_{si} = I_{s1} * K_{mi1} + I_{s2} * K_{mi2} + \dots + I_{sn} * K_{min},$$

where  $I_{s1}$  is a self-evaluation of the first interest (1 to 5) by the student,  $K_{mi1}$  is the first keywords “rating” (rated from 1 to 5) of the engaging material, identified with  $i$ . If each

student created an engaging material, the maximum value of I corresponds to the number of students. If the method is used in other courses, groups, or the next year – the number of engaging materials increases, making the choice richer.

2. Moodle LMS: implementation of the personalized content of spaces in the course content, determined by the learners ID.



**Figure 2:** Flowchart of information system for implementation of spaced e-learning.

## 6.2. Spaced e-learning content personalization approach

Moodle LMS personalized spaced learning content tool was developed to provide students with a personalized content in the format of YouTube videos, Prezi/Google presentations. The content is displayed in Moodle LMS in specified learning content items. The selection of the personalized content is based on predefined rulesets expanded from a survey carried out during the online course. Figure 3 depicts the data flow and content rendering process as spaced learning content is requested by a student. The process starts with the content page request which sends a set of parameters to the content generation script. The script requests personalized dataset from data storage (Google sheets/other database) and generates content to be displayed on Moodle LMS. Moodle LMS personalized spaced learning content tool has three main components:

- 1) EMBED TAG in Moodle LMS content,
- 2) HTML Content generation script,
- 3) External data repository (Google sheet/Database).

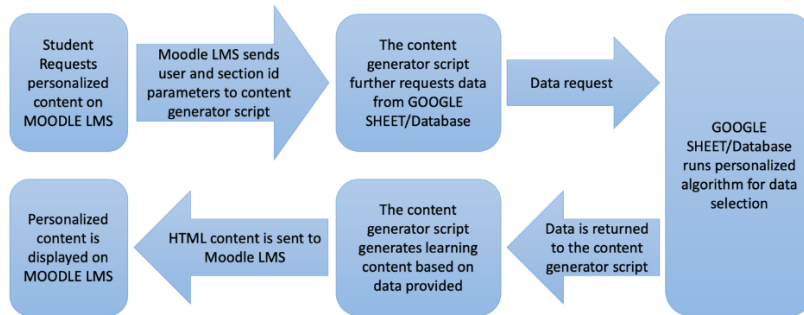


Figure 3. Moodle LMS personalized spaced learning content tool.

### 6.3. EMBED TAG in the Moodle content

HTML EMBED TAG (WEB, i) was selected for displaying personalized content as it provides all required features and is supported across all WEB browsers. The EMBED TAG was added to Moodle LMS content pages providing a placeholder for the personalized content. Parameters such as user ID and section ID were included as tag parameters. If setup requires any other student specific variables these can be included such as *firstname*, *lastname*, *group ID*, etc.

Moodle LMS personalized content page request by a student initiates custom content generation as depicted in the Figure 3. The EMBED TAG sends parameters to the content generation PHP script located on Moodle server. The script further requests personalized data from Google sheets/Database (depending on setup) and generates content embedding it in the content area enclosed by the EMBED TAG. Technically embedded content is created externally and injected into Moodle LMS content.

A preinstalled Moodle plugin *FilterCodes* (WEB, c) is required to ensure full functionality of the EMBED TAG. As described before *FilterCodes* plugin provides content personalization features in a form of plain text tags in a Moodle content site. *FilterCodes* plugin provides *user id*, students *firstname*, *lastname* parameter for EMBED TAG. If required other text tags from student's profile are available from the plugin.

The EMBED TAG is inserted in Moodle learning content (by switching *Wysiwyg* editor into HTML mode) in format displayed below:

```
<embed frameborder="0"
src="https://artss.mii.lv/local/customcontent.php?firstname={firstname}&
lastname={lastname}&userid={userid}&spaceid=3" width="900" height="500">
```

All the values included in the TAG are sent to the content generation script (*firstname*, *lastname*, *user id*, *space id*). Further width and height variables provide extra formatting options. Personalized content generation will be based on these values only. The content generation script will not be able to access any other information from the Moodle LMS site.



### **Content generation script (content.php)**

The content generation script written in PHP7 (WEB, e) generates personalized content in HTML using parameters included in the EMBED TAG. Any other programming language or online service can be used for this. The only requirement is the script/service has to be able to accept variables from the EMBED TAG and return content in HTML format.

The content generation script performs the following tasks:

- 1) Content generation script receives variables from the EMBED TAG and validates them.
- 2) It requests personalized data from Google Sheets using PHP library Google PHP API Client Services (WEB, d). Data request includes an authorization request and a data query after that.
- 3) It generates HTML content using data from Google Sheets and returns it to EMBED TAG located in learning content.

## **6.4. External data repository**

All data for personalized content generation is stored and managed by an external data repository. We use Google Sheets as it provides a flexible environment for testing different algorithms using formulas and data analysis tools. Any other data storage can be used and is more suitable for larger scale implementations.

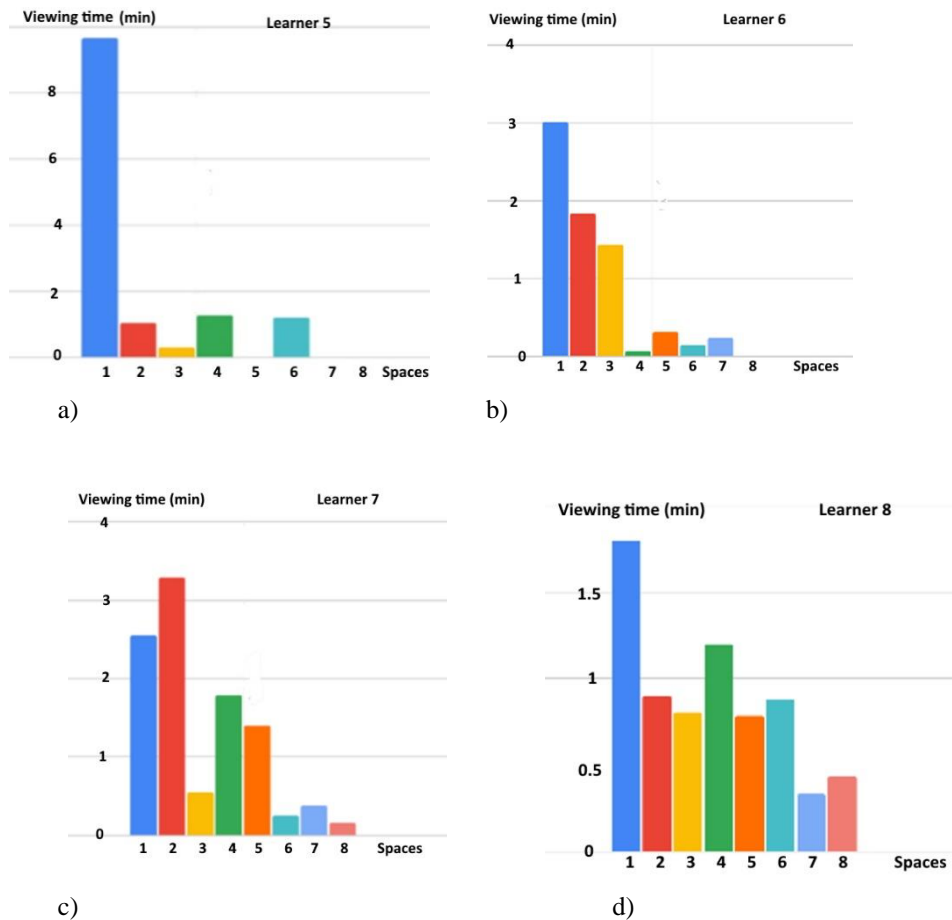
Google Sheets lists all WEB content locations of spaced learning personalized content and assigns them to a specific student ID using a set of Google Sheets functions.

## **7. Living Lab outcomes**

The objective of the Living Lab is to validate the technology of the IS for spaced e-learning and for evaluating the effectiveness of the course. All learners it was previously stated by analysis of the outcomes from the first prototype that learners' created content for spaces should be tailored to their individual interests.

Recommended content is to link interests to the business idea, recommended forms are YouTube video, ppt, Google slides, Prezi or other presentation tools. Recommended length of watching is about five minutes. Some students created engaging material, some – not so much. Predictable length of watching was two to seven minutes.

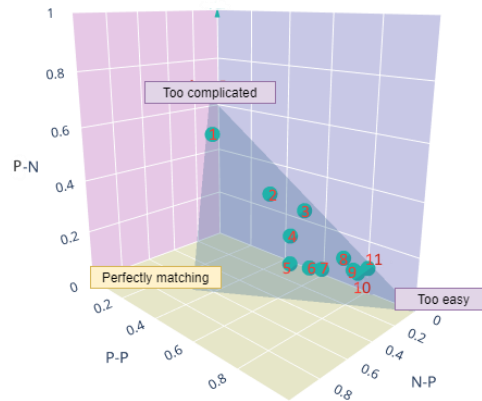
All learners acknowledged that the content of spaces was appropriate to their interests, with relevance declining in subsequent spaces. Using Log Export tools of the Moodle LMS, time of watching spaces' content was analysed. Fig. 4 shows changes of spaces' viewing time, supporting the decrease of the interest of the learners in the content of spaces for four students. Viewing time was also determined by the quality of the content. Interest to the course-mates content also weakly correlated to the learning outcomes, but statistical analysis is not possible due to the small number of learners. It is also important that several materials were very short, so it was not possible to fully "disconnect" the brain from the course content while watching them.



**Figure 4.** Changes of spaces' viewing time of 8 spaces in the Moodle LMS Business e-course.;

- a) Learner 5 completed 33 % of the theory tests, did not master the practical part;
- b) Learner 6 fully mastered the theory (100%) , do not complete practical part;
- c) Learner 7 completed 100% theory and practical part;
- d) Learner 8 was successful in the theory completion (66 %), did not master the practical part.

The TELECI method, created by the researchers from Riga Technical University (Kapenieks et al., 2020) is used for evaluation of the appropriateness course content and design to the needs of individual learner. Differences between the number of right and wrong answers at the end and beginning of small subunits are used to evaluate the appropriateness of the learning content to the objectives of the course/unit and the appropriateness of the course content and design to the needs of the individual learner. (Kapenieks et al., 2020). Data for analysis is calculated as the probability of differences between right and wrong answers. The authors of the method provided the following “ideal” experimental average probability values for the characterization of the course, if



**Figure 5.** TELECI analysis data of the 11 Business course learners after the course.

**Table 1.** Evaluation of the appropriateness of the Business spaced e-learning e-course to the individual students' needs by the TELECI method.

Learner	Perfectly matching	Too easy	Too complicate	Use of spaces	Fin. asesment Theor./practice
1	0.29	0.18	0.53	0	no
2	0.22	0.44	0.33	0	no
3	0.14	0.57	0.29	0	no
4	0.24	0.56	0.20	6	33%/no
5	0.30	0.59	0.11	6	33%/no
6	0.24	0.66	0.10	7	100%/no
7	0.21	0.69	0.10	8	100%/done
8	0.11	0.74	0.14	8	66%/no
9	0.11	0.78	0.11	4	33%/no
10	0.10	0.80	0.10	8	33%/done
11	0.06	0.82	0.12	yes	33%/done

each multiple-choice question has three answers (Kapenieks et al., 2020): too complicated:  $N-P = 0.222$ ;  $P-P = 0.111$ ;  $N-N = 0.444$ ;  $P-N = 0.222$ ; too easy:  $N-P = 0$ ;  $P-P = 1$ ;  $N-N = 0$ ;  $P-N = 0$ ; perfectly matching to learners' needs:  $N-P = 0.667$ ;  $P-P = 0.333$ ;  $N-N = 0.444$ ;  $P-N = 0$ . The Appropriateness of the course for each student is characterized by the dot in the 3D diagram (Fig. 5). Figure 5 shows that theoretical part of the spaced e-learning course is quite well matched to most learners' needs and looks too complicated only for those that did not watch the content of spaces (Table 1). Table 1 shows the TELECI evaluation data from spaced e-learning Business course and the corresponding learning outcomes. We cannot make statistically justified conclusions from few cases on the effect of the method on the results.

## 8. Discussion and further research

Previous research showed effectiveness of the spaced e-learning method, improving outcomes of computer-based learning. The COVID-19 crisis increased importance of pedagogical solutions in the internet learning environments, spaced learning is one of them. The Google tools based information system provides compatibility of the personalized content of spaces with different e-learning environments and it is available for everybody.

All the participants of the Living Lab consider that the use of the method should be voluntary - it allows the learner to ignore pauses whilst learning. Personalized and attractive content of spaces increases motivation to “disconnect” the brain during learning before repetition of the learning content. It is provided by the information system – combination of the Google tools with personalization module in the e-learning environment.

Spaces content creation by learners requires learners to have the capabilities to create the story based upon their personal interests, empathy to their group-mates and multimedia designing skills. The Living Lab showed younger learners as being the more successful content creators. They are experienced by the social networking or even multimedia processing. The content created by students in the initial part of the research was able to generate the interest of their course-mates and most of them watched the content of spaces between repetitions. Living Lab experiments showed a lack of content creation skills amongst the older generation, therefore, only some of the material was readily viewed by others.

There are some limitations in the implementation of the spaced learning method. It increases learning time, therefore some learners come to terms with lower results achievement due to lack of time for learning. Limitations may also be caused by the unsuitability of the student's learning style to the spaced learning method.

The appropriateness of the spaced e-learning solutions is an important topic for the further spaced e-learning research. Another important topic for the IS designers, is the creation and research of spaced e-learning content personalization plugins for other e-learning environments. In several cases, they would be based on already available

content personalization solutions. There is also a wide range of topics for spaced learning pedagogical research.

## 9. Conclusions

The Living Lab of the information system for personalization of the content of spaces allowed the implementation of spaces in the course in accordance with learners' predefined conditions. In the Living Lab such conditions are the individual interests of learners.

Technological solution of the IS allows the use of this method for a wide range of pedagogical approaches, including personalized content for each learner, the use of individual educational tools and forms of delivery of the learning content. Google drive implementation for creation of the dataset for personalization makes the method available for everybody and different LMS with a corresponding change in the LMS code.

It is important to follow learners' behaviour in the spaced e-learning LMS, gathering information from log files and progress ratings. Created IS allows us to receive information on the behaviour in the learning material with spaces. The TELECI method allows dynamically follow the compliance of the course design and content with the needs of users and to anticipate the achievement of the objectives.

On the other hand, the implementation of the spaced learning method and the TELECI tool requires additional work on the part of the lecturer and their team.

User behaviour data from the Living Lab does not show noteworthy correlation between use of spaces and final results. Such a correlation would be evaluated for a larger number of learners and high-quality content of spaces with the length from 10 to 15 minutes. During the implementation of the first prototype for master's level students in the OpenEdX LMS the quality of students' created spaces' content was much better and learners were more engaged in the content of spaces than the learners of the continuing education course in the Living Lab (Kapenieks and Kapenieks, 2020; Kapenieks and Kapenieks, 2021). The COVID-19 crisis seriously hindered the methods for full-fledged approbation from a pedagogical point of view, but provided an opportunity to verify the technological solution.

## Acknowledgement

This work has been supported by the European Regional Development Fund within the Activity 1.1.1.2 "Post-doctoral Research Aid" of the Specific Aid Objective 1.1.1 "To increase the research and innovative capacity of scientific institutions of Latvia and the ability to attract external financing, investing in human resources and infrastructure" of the Operational Programme "Growth and Employment" (No.1.1.1.2/VIAA/1/16/156).

## References

- Bates, A. W. T. (2019). *Teaching in a digital age: Guidelines for designing teaching and learning*. Retrieved from <https://opentextbc.ca/teachinginadigitalage/>
- Carpenter, S. K., Cepeda, N. J., Rohrer, D., Kang, S. H. K., Pashler, H. (2012). Using spacing to enhance diverse forms of learning: Review of recent research and implications for instruction. *Educational Psychology Review*, **24**(3), 369–378.
- Ebbinghaus, H. (2013). Memory: A contribution to experimental psychology. *Annals of Neurosciences*, **20**(4), 155.
- Kahana, M. J., Howard, M. W. (2005). Spacing and lag effects in free recall of pure lists. *Psychonomic Bulletin & Review*, **12**(1), 159–164.
- Kapenieks, A., Daugule, I. (2020). Knowledge Acquisition Data Visualization in eLearning Delivery. *12th International Conference on Computer Supported Education CSEDU*. Prague: CSEDU.
- Kapenieks, A., Daugule, I., Kapenieks, K., Zagorskis, V., Kapenieks, J., Vitolina, I. (2020). TELECI approach for e-Learning User Behavior Data Visualization and Learning Support Algorithm. *Baltic Journal of Modern Computing*, **8**(1), 129-142.
- Kapenieks Sr, J., Kapenieks Jr, J., (2020). Spaced E-learning for Sustainable Education. *Journal of Teacher Education for Sustainability*, **22**(2), 49–65.
- Kapenieks Sr, J., & Kapenieks Jr, J., (2021). Spaced e-learning solution in the e-learning environment. In B. Csapó and J. Uhomobhi (Eds.), *Spaced learning solution in the e-learning environment, Proceedings of the 13th International Conference on Computer Supported Education CSEDU 2021* (pp. 169–176). Retrieved from <https://www.scitepress.org/PublicationsDetail.aspx?ID=NemG8z+997Y=&t=1>
- Kelley, P., Watson, T. (2013). Making long-term memories in minutes: a spaced learning pattern from memory research in education. *Frontiers in Human Neuroscience*, **7**, p. 589. Retrieved from <https://www.frontiersin.org/article/10.3389/fnhum.2013.00589>
- Kerfoot, B. P., Fu, Y., Baker, H., Connelly, D., Ritchey, M. L., Genega, E. M. (2010). Online spaced education generates transfer and improves long-term retention of diagnostic skills: a randomized controlled trial. *Journal of the American College of Surgeons*, **211**(3), 331–337.
- Klemm, W. R. (2012). *Memory Power 101: A Comprehensive Guide to Better Learning for Students, Businesspeople, and Seniors*. Skyhorse.
- Pappas, C. (2016). 6 Tips To Develop Spaced eLearning Courses - eLearning Industry. Retrieved October 12, 2019, from eLearning Industry website: <https://elearningindustry.com/6-tips-develop-spaced-elearning-courses>
- Paul, K. (2014). *Study smarter, not harder*. Self-Counsel Press.
- Prasad, R. K., Omer, A. H. (2019). CommLab India blog: Spaced Learning: The Ambrosia for Knowledge Retention. Retrieved from CommLab India website: <https://blog.commlabindia.com/elearning-design/spaced-learning-elearning-knowledge-retention>
- Schimanke, F., Ribbers, S., Mertens, R., & Vornberger, O. (2016). Implications of Short Term Memory Research for the Design of Spaced Repetition Based Mobile Learning Games. *Proceedings - 2015 IEEE International Symposium on Multimedia, ISM 2015*, (December), 571–576. <https://doi.org/10.1109/ISM.2015.13>
- Shaw, T., Long, A., Chopra, S., Kerfoot, B. P. (2011). Impact on clinical behavior of face-to-face continuing medical education blended with online spaced education: a randomized controlled trial. *Journal of Continuing Education in the Health Professions*, **31**(2), 103–108.
- Versteeg, M., Hendriks, R. A., Thomas, A., Ommering, B. W. C., Steendijk, P. (2020). Conceptualising spaced learning in health professions education: A scoping review. *Medical Education*, **54**(3), 205–216. Retrieved from <https://onlinelibrary.wiley.com/doi/full/10.1111/medu.14025>

- WEB (a). *Availability conditions*. (n.d.). Retrieved from <https://moodle.org/plugins/browse.php?list=category&id=57>
- WEB (b). *Building\_Lesson @ docs.moodle.org*. (n.d.). Retrieved from [https://docs.moodle.org/310/en/Building\\_Lesson](https://docs.moodle.org/310/en/Building_Lesson)
- WEB (c). *FilterCodes*. (n.d.). Retrieved from [https://moodle.org/plugins/filter\\_filtercodes](https://moodle.org/plugins/filter_filtercodes)
- WEB (d). *google-api-php-client-services @ github.com*. (n.d.). Retrieved from <https://github.com/googleapis/google-api-php-client-services>
- WEB (e). *Index @ Www.Php.Net*. (n.d.). Retrieved from <https://www.php.net/>
- WEB (f). *Quiz\_settings @ docs.moodle.org*. (n.d.). Retrieved from [https://docs.moodle.org/2x/pl/Quiz\\_settings](https://docs.moodle.org/2x/pl/Quiz_settings)
- WEB (g). *Restrict\_access @ docs.moodle.org*. (n.d.). Retrieved from [https://docs.moodle.org/310/en/Restrict\\_access](https://docs.moodle.org/310/en/Restrict_access)
- WEB (h). *Restriction by single quiz question*. (n.d.). Retrieved from [https://moodle.org/plugins/availability\\_quizquestion](https://moodle.org/plugins/availability_quizquestion)
- WEB (i). *tag\_embed @ www.w3schools.com*. (n.d.). Retrieved from [https://www.w3schools.com/tags/tag\\_embed.asp](https://www.w3schools.com/tags/tag_embed.asp)

### Authors' information

**Janis Kapenieks Sr.**, Dr. Paed., is senior researcher in the Distance Education Study Centre of Riga Technical University. Background in the pedagogy, physics and social sciences provides basis for transdisciplinary research in the field of e-learning technologies and methodology with the goal to increase learning effectiveness of e-learning by implementation of latest findings of pedagogy in the learning management system design.

**Janis Kapenieks Jr.**, Mg. oec., MBA is a researcher working for Distance Education Study Centre at Riga Technical University. Background in the field of IT solutions development and maintenance for business and educational institutions. Author's research is related to data collection from LMS and visualization for learning analytics as well as development of LMS plugins.

Received August 2, 2021, revised September 30, 2021, accepted November 2, 2021