The choice of customisation strategies in training: An overview of parameters and their systematisation

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This paper discusses the factors that determine the customisation of e-learning programmes. The process of customisation depends on many parameters, such as the objectives of the programme, the quantity and order of the learning materials, the personality and abilities of the student, and the resources within the learning system. Curriculum developers are able to put together these parameters in varying combinations, reflecting differing educational strategies. Because of this possibility it has become important to study how one can determine an appropriate strategy or learning path for any individual student. This is becoming particularly relevant because curriculum developers have to consider large numbers of already developed learning courses, modules, and technologies. One of the approaches to addressing this problem is the classification, or taxonomy, of customisation parameters. This paper reviews published material from highly-rated journals dealing with customisation of learning. As a result of this review the groups of customisation parameters are identified and a generalised scheme of grouped parameters, and their sequence, corresponding to the inner logic of the learning process are developed. This taxonomy allows the educational activities to be arranged so that learners can achieve their learning goals more efficiently.

Implications for practice or policy:

- The developers of curricula and learning materials can use the proposed taxonomy for structuring learning materials within the course, as well as for choosing the forms and methods of their elaboration.
- The developers of e-learning systems or modules can use the proposed taxonomy for planning and enhancing the functionality of their systems.

Keywords: e-learning, customisation strategy, activity of the trainee, individual schedule, taxonomy

Introduction

In recent years, in university education, an approach has been accepted that implies the use of teaching methods that focus the responsibility for the results on learners, rather than on teachers (Biggs, 2012; Kember, 2009). Not only the knowledge we have, but our ability to apply this knowledge and the link between science, education, and industry is important (Burkle & Cobo, 2018). The skills of graduates should meet the expectations of employers (Lee & Chin, 2017). Each person has a unique set of knowledge, skills, and personal qualities. A personalised approach to training has become widespread as it allows the most effective use of available resources in achieving unique goals. A personalised, or customised, approach refers to any pedagogical action that takes into account the individual and personal needs of the student. This study has been conducted as a part of more extensive work aiming at adaptation of the content of the learning course in order to meet the expectations, the learning goals and capabilities of the learner within the scheduled time. When planning and implementing customised training, effective use of the time allocated for training requires the development of customisation strategies (Essalmi et al., 2015). Such strategies combine various customisation parameters that best match the learner and the learning environment. This study continues and expands existing research on this topic.

Some sources (Kahiigi et al., 2008), define learning as the process of achieving learning goals through the implementation of learning activities, interacting with each other and with the learning environment. The result of the learning process is the ability to modify acquired knowledge and skills for solving new problems. This implies an active role of the learner in the learning process. During learning a person's ability to do something changes, which means their behaviour changes. These changes are the result of practice or experience, and they are sustainable (Kahiigi et al., 2008). To achieve these changes requires a certain amount of knowledge, practice in applying that knowledge, and becoming familiar with the assessment methods relevant to the desired learning goals. Since the learner changes during the learning

process, in order to make the process effective it is necessary to determine the specific personal attributes of each learner – the individual characteristics of their information perception and processing, which affect the way they organise their learning.

Adaptation implies adjusting the content during training - its composition, sequence of study, and presentation to the student. Thus, to help learners achieve the learning objectives, it is important to provide the required content, and also to ensure proper interaction of learners with this content. Content assures the achievement of learning goals, and adaptation allows us to achieve them more effectively. Customisation is one of the mechanisms of adaptation of the content of educational materials in accordance with the individual needs and goals of the student. Adaptation is carried out using different customisation methods for different aspects of learning.

Methods and forms of interaction of the learner with the content depend on the individual learner and on the way this interaction is organised, and are determined by the inner logic of the process of learning. It is also important what tools and approaches are used to help learners master the learning material. There is a lot of research on implementation of e-learning technologies, however it is important to not only introduce this, but to reflect on the benefits it brings (Duart & Mengual-Andrés, 2015). To date the use of pedagogic principles in modern teaching technologies, especially in higher education, has been poorly studied (Bartolomé et al., 2018).

Therefore, the relevant task is to design educational programmes that will correspond to the future professional activities of students, while optimising the use of available educational resources: the cognitive and personal characteristics of students and the capabilities of learning technologies. Systematisation of such a wide range of factors will allow a systematic approach to the design of the learning process, as well as to the development of e-learning systems. This paper presents a taxonomy of customisation parameters that allows developers of e-learning systems to plan functionality for customisation. The presence of such functions in training systems will allow teachers to develop customisation strategies in accordance with the stages of training, the goals achieved, and the characteristics of the student.

Analysis of customisation methods used in learning systems

For the purpose of analysis of customisation approaches in learning systems currently employed in educational institutions, the reviews of other authors have been explored. Somyürek (2015) noted an increase in suggested content and the growing responsibility of learners for learning outcomes led to some problems, such as disorientation and cognitive overload of learners in learning environments. She concluded that the use of customisation on real e-learning platforms is not widespread due to limitations in their functionality.

Wilson and Scott (2017), explored the use of adaptive systems in learning, and compared intelligent tutoring systems and adaptive hypermedia systems. The latter supports learner-oriented approaches to a higher extent than the former, but is still insufficient in providing the learner with freedom in choosing approaches in learning. Learning management systems and adaptive hypermedia systems were also compared in (Lerís López et al., 2015), and the adaptive capabilities available in the Moodle learning management system were explored.

In Essalmi et als. (2010) study, 22 learning systems are explored. Eighteen of the explored systems used the learner's level of knowledge as a customisation parameter. Although the learning goal parameter was also used. The learning goal being the type of information transformation (knowledge, understanding, application). Only four systems used parameters characterising the learner (e.g., learning style, initial level of educational attainment).

In Tsortanidou et als. (2017) study there were 20 adaptive hypermedia systems categorised according to the types of adaptation used by the learner. Analysing the results obtained by these authors, we concluded that the vast majority of the training systems adapt the content, addressing the preferences and needs of learners and their learning styles. Only a quarter of the systems combine this type of customisation with other types, such as the level of knowledge and initial level of educational attainment. Only a few systems use the learning goal and navigational choices as adaptation parameters. In Figures 1 and 2 show how often certain customisation parameters are mentioned in learning systems.

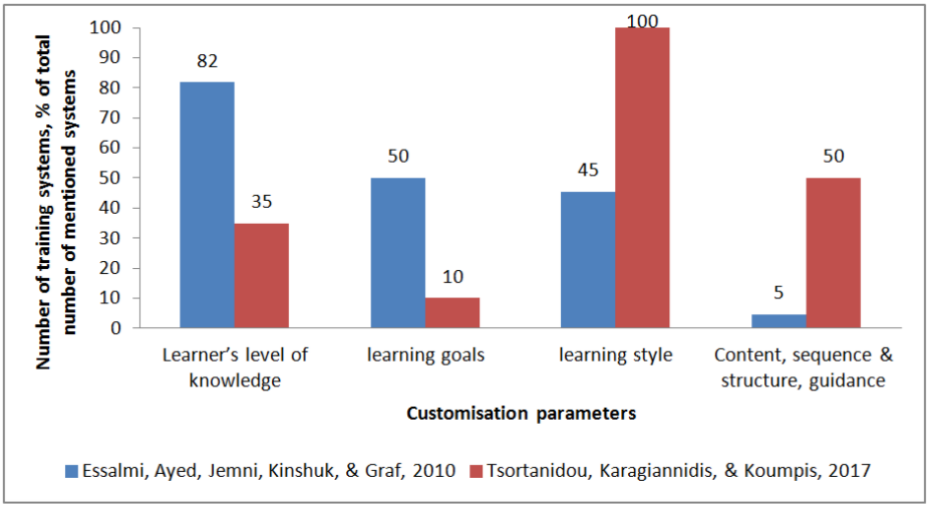

Figure 1. Number of training systems that use the different customisation parameters

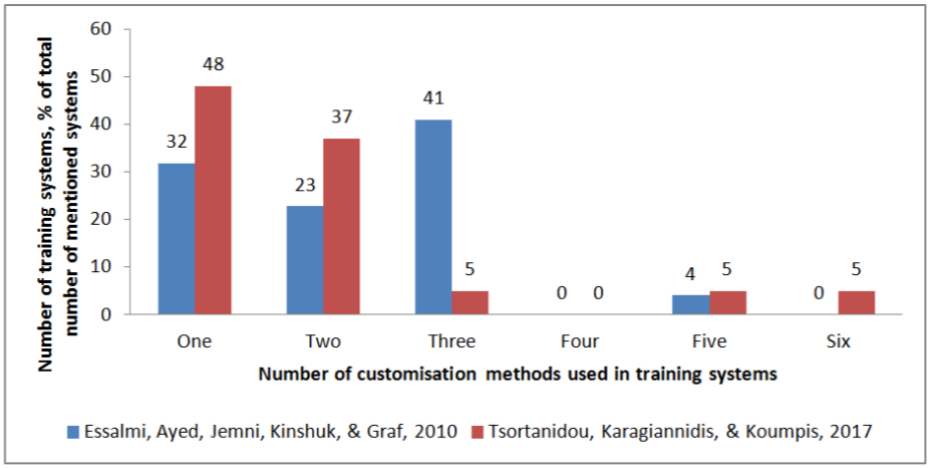

Figure 2. The number of customisation methods used in training systems

These results confirm the thesis that the e-learning systems operate with a limited number of customisation parameters. This is a limitation for the learner in the realisation of their goals and abilities. Therefore, it can be argued that the electronic systems, used in learning, intensively tend towards what can be called *advisory systems*, where information in the learning environment is filtered based on the context meaningful for the learner. The development of learning systems with maximum customisation capabilities requires considering a large number of parameters and their mutual influence. This aspect is poorly represented in existing studies.

Method

Our review process used the phases recommended by Brereton et al. (2007). The developed review protocol covered the following processes: determining the review's purpose, defining inclusion/exclusion criteria, search and selection of studies, data analysis, interpretation, and discussion of results.

Determining the review's purpose

The main objective of this study was to streamline customisation methods in accordance with the inner logic of the learning process for organisation of an individual training schedule. For this purpose the three guiding questions were drawn up. These questions were used to form retrieval requests and arrange the process of analysing the obtained results, and were:

1. What factors influence the learning activity of the learner?
2. What factors in the learning process determine the learning trajectory?
3. What factors influence the time period required to achieve the learning goals?

The guiding questions were primarily aimed at ensuring that the publications being reviewed allowed us to analyse what aspects of learning were affected by different customisation methods. For the purposes of this research learning was considered as using various tools, including electronic ones. This was necessary so that further results and conclusions about the use of modern technologies in the educational process corresponded to the inner logic of the learning process.

Defining inclusion/exclusion criteria

In the second phase of the literature review, inclusion and exclusion criteria were determined as described in Table 1.

Table 1
Inclusion and exclusion criteria - pre-selection of documents

Inclusion criteria	Article were published in the 1st or 2nd quartile of journals. Customisation of learning was the central topic. Valid documents were research articles, review articles, or books. Valid documents corresponded to the keywords: e-learning, customisation, personalization, or learning. Valid documents included the description of customisation techniques or educational systems with the possibility of customising education in higher education institutions. Valid documents were published between the years 2000 and 2018. Valid documents contained relevant information to answer some of the guiding questions.
Exclusion criteria	Notes and editorials were excluded. Documents on specifics of customisation of learning in special professional areas and specific academic disciplines, were excluded.

Search and selection of studies

To search and systematise published articles, a multiphase procedure was used (Figure 3). The stages of this procedure were as follows: (a) systematic search in electronic databases, (b) screening to exclude documents that do not meet the eligibility criteria, and (c) systematisation of the selected articles.

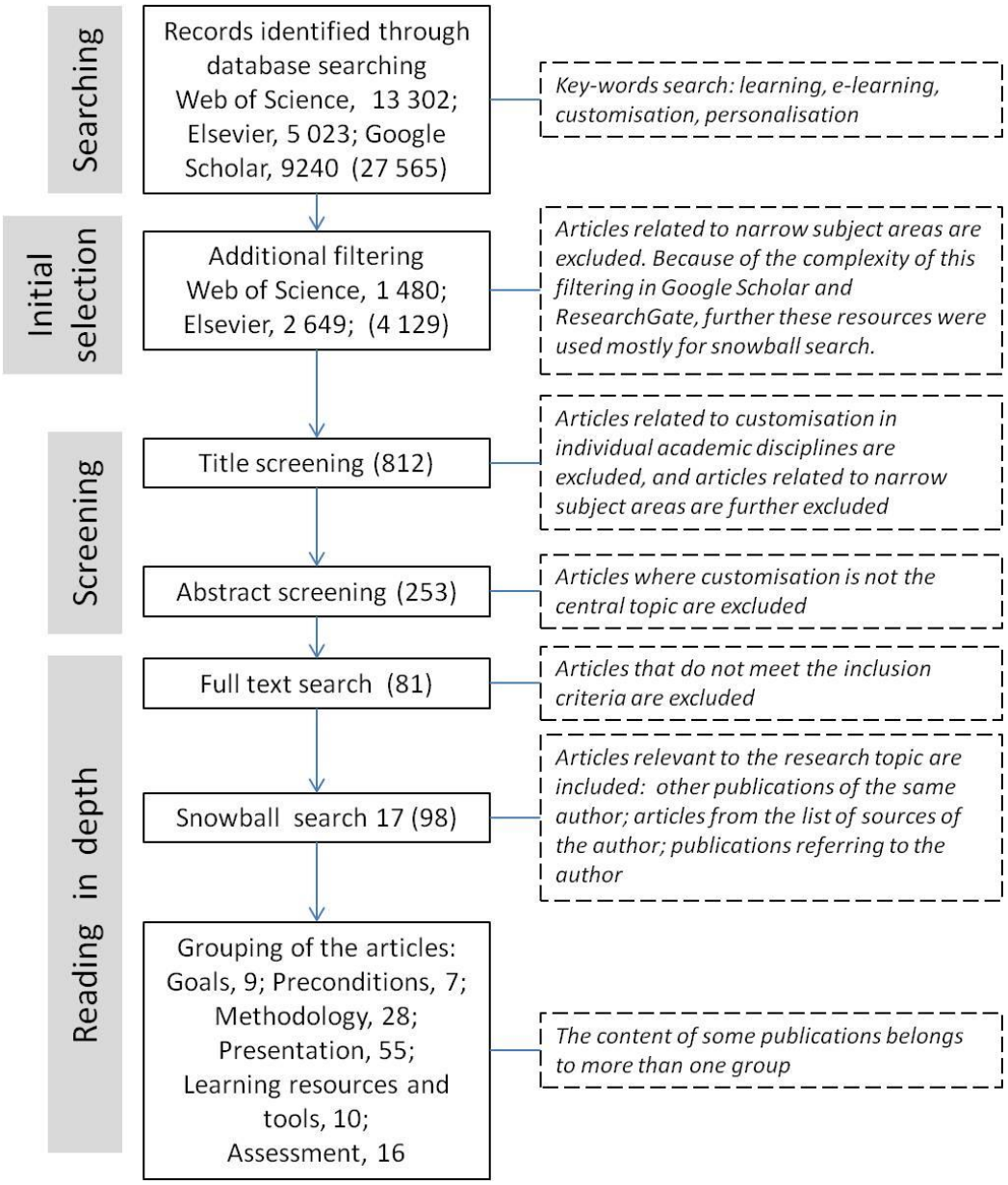

Figure 3. Multiphase procedure for searching, screening, and systematising articles

Initial searching

This phase was divided into three steps. First, the databases to be searched were selected. Due to the nature of the review topic, several major databases that covered research papers in peer-reviewed, high impact factor journals were chosen: *Web of Science* scientific citation database, the *ScienceDirect* by Elsevier publishing house, the Google Scholar search engine, the *ResearchGate* network. Second, the keywords, e-learning, customisation, and personalisation, were applied to the search. Finally, the filtering process was applied according to the type of document and period of publication. This initial searching led to 27,565 results.

Initial selection and screening of studies

For the documents obtained in the initial search phase, additional filtering was done to exclude documents on specifics of customisation of learning in special professional areas and specific academic disciplines. As a result, 4129 articles on customisation approaches applicable in more than one area remained for the analysis. Further, the analysis of title, keywords, annotation, and conclusions of the articles was carried out

based on the inclusion/exclusion criteria. Finally, 253 documents were pre-selected for a more detailed study.

Reading in depth

A more detailed study of the preselected documents was undertaken to identify the availability of information necessary to answer the guiding questions. The key ideas were defined and generalised. This allowed us to identify certain aspects of learning. Each such aspect had corresponding customisation parameters which allowed these aspects to be integrated into the learning system. The selection included full-text publications containing the description of approaches to customisation of training in the general context, mainly in higher educational institutions. In addition, a snowball search was performed to identify related publications. As a result, 98 publications were ultimately selected to be included in the review.

Data analysis

The defined aspects of learning were then analysed and grouped according to the inner logic of the learning process. Additionally, when studying the selected publications, two groups of articles were distinguished: (1) publications where customisation parameters were classified, and (2) publications which described the methods of implementing various approaches to customisation.

Interpretation

Interpretation of the results was carried out in accordance with the stated goal, the key questions, and the defined aspects of learning in the two selected groups of publications. Customisation methods and their implementation were noted in the analysed articles. Customisation parameters were grouped according to the aspect of learning affected by those parameters. In this way the logical sequence of these groups was determined, and the taxonomy of learning customisation parameters was obtained. The key ideas about customisation strategies from these publications were also correlated with determined aspects of learning to obtain a new list of the customisation parameters which facilitate integration of these aspects into the e-learning environment.

Discussion of results

This last phase was associated with identification of the relevance and the methods of implementation of the results in developing an individual training schedule. In addition, possible opportunities for future studies in this area were considered.

Results

The process of learning involves various factors and each of them has corresponding customisation parameters which influence the implementation of these factors in the learning system. All customisation parameters aim at different targets, which in turn correspond to different learning processes. To achieve the stated goals the aspects of learning were first identified, then grouped according to the inner logic of the learning process. The list of customisation parameters corresponding to them was then obtained.

Aspects of learning

The initial outcome of this process was the definition of aspects of learning identified in accordance with the guiding questions of the study.

1. What factors determine the learning activity of the learner?

Analysis of the publications showed that learning activities were always aimed at acquiring knowledge, skills, and abilities to perform certain tasks. Accordingly, the goals aspired to determine how learning activities were organised. Based on this the learning activity was determined by the internal and the external environment of the learner. The internal environment included motivation, the initial level of educational attainment and the learner's personality. The external environment included the learning environment, resources for learning and the requirements or expectations of employers. Identified aspects of learning

were: motivation, learning goals, learner needs, initial level of educational attainment, learning environment, learner satisfaction, workload, and allotted time of training.

2. What factors in the learning process determine the learning trajectory?

To answer this question, trends in the use of e-learning systems were analysed. The following trends were discovered:

- Currently, due to the rapid development of e-learning tools, advisory systems are being developed. They are able to compile and provide the learning content depending on learning goals, performance, work rate, and personality characteristics of the student. In addition, they can advise the students about the sequence of content study based on the structure of the links between different parts of the learning material.
- The learning content is generated, and the methods of presentation are chosen with regard to the capabilities of the learning environment.
- When using modern technologies in the learning process it is important to base them on correct pedagogical foundations.

Identified aspects of learning were: resources, set of training materials, evaluation of results, description of the subject area, pedagogical approaches, succession of learning materials, and complexity of the learning material.

3. What factors influence the time required to achieve the learning goals?

The analysis of various publications showed that the time required to internalise the educational material was influenced by the cognitive abilities of the student and the organisation of their work with this material. By organisation of work, we mean building a rational interaction-of the student with the learning material, the learning environment, and other participants in the learning process. The rationality of the organisation of the student's work depends on their particular skills and personal abilities. The following aspects of learning were identified: mental processing speed, form of presentation of learning materials, and the learner's personality.

Structure of the groups of customisation parameters

The second result of this research was the list of customisation parameters classified into groups (Appendix A). This was a result of the analysis carried out using the key ideas of the articles and the aspects of learning outlined above. While studying the selected publications, no works were found that explored the time allotted for learning and the tempo of the student's work, their impact on the amount of studied content or the schedule of study in the context of use of electronic educational systems.

Taxonomy of customisation parameters

The third outcome of this research was a taxonomy of the customisation parameters corresponding to the inner logic of the learning process. To form a customised learning trajectory within an advisory system, it is necessary to operate not only with customisation parameters, but also with their interdependence, that is, some groups of parameters should be dominant over the others. Hence, systems with a customised learning mechanism must consider the relationship between the learner's attributes (e.g., learning style, domain knowledge) and the learning materials, so that the learner can develop a learning goal adapted to those attributes.

Tankeleviciene and Damasevicius (2009) classified the customisation methods and their aspects. They identified the following groups of customisation parameters: technological (capabilities of the training system); pedagogical approaches; features introduced by electronic interaction; organisational; psychological characteristics of learners; subject domain; and learning goals. Khamparia and Pandey (2018) presented the classifications of learning attributes in order to optimise the learning sequence and maximise learning outcomes in computer programming courses. Mbendera et al. (2010) defined the following groups of a learner's features: (1) by the type of internal construction of knowledge – from general to specific or vice versa; (2) by the type of decision-making – reflective or impulsive; (3) by the

type of cooperation – introvert, extrovert; (4) by the type of preferred information – preferences for real, practical or theoretical, abstract information; (5) by the type of senses involved; and (6) by the initial level of educational attainment. As a result, Mbendera et al. compiled a formula for the requirements for customised information, which also determined the sequence of application of customisation parameters for this research.

A general taxonomy of adaptive e-learning to facilitate the formation of individual content for the student was presented in Premlatha and Geetha (2015). Four levels of adaptation were distinguished: (1) the content level; (2) the link level; (3) the level of learning content presented; and (4) the learner level. This taxonomy showed the relationship between the levels of adaptation and their components. Based on these parameters, e-learning systems offer individual information for the learner.

Considerable work in the field of systematisation of customisation parameters was carried out by Essalmi et al. (2015). Nineteen customisation parameters most often used in e-learning were identified. They were divided into three groups: (1) the purpose of training and motivation (why learn); (2) resources which allow composing personalised content (what to learn); and (3) learning methods, to account for the individual differences of learners in terms of their perception and processing of information (how to learn). As a result, this research developed a taxonomy of customisation parameters, which may help to reduce effort in development of customised courses by choosing an appropriate customisation strategy.

The common shortcomings of parameters for learning customisation in the reviewed systems were identified as: no, or only weak, correlation with the aspects of learning as elements of an interrelated process and with the learning goals; and narrow range of possible aspects of learning customisation being addressed. The taxonomy of customisation parameters proposed in this research, addressed these shortcomings. Previously identified aspects of learning were grouped into six groups (Appendix A) which comprehensively described the logic of the learning process. For this purpose, the classification from Essalmi et al. (2015) was used as the most congruent to this research. During the research work this classification was also expanded and elaborated.

Based on the explored learning process theories and approaches to learning customisation, the previously identified aspects of learning were grouped in accordance with the logics of the learning process. The sequence of these groups was based on the following assumption: learning is the process of achieving learning goals by learners, and all the activities of teachers and learners are interactions with each other and with the learning environment (Biggs, 2012; Essalmi et al., 2015; Kahiigi et al., 2008). In this case, formalised learning goals determine what should be taught, that is, the educational content. The sequence in which the learner is provided with the content and the forms of its presentation belong to the category of questions about how to teach, and should reflect the pedagogical goals, learner's goals and abilities, as well as the capacities of the learning environment. Also, any learning process includes assessment of the achievement of the learning goals. As a result, the following taxonomy of groups of customisation parameters was proposed (Figure 4).

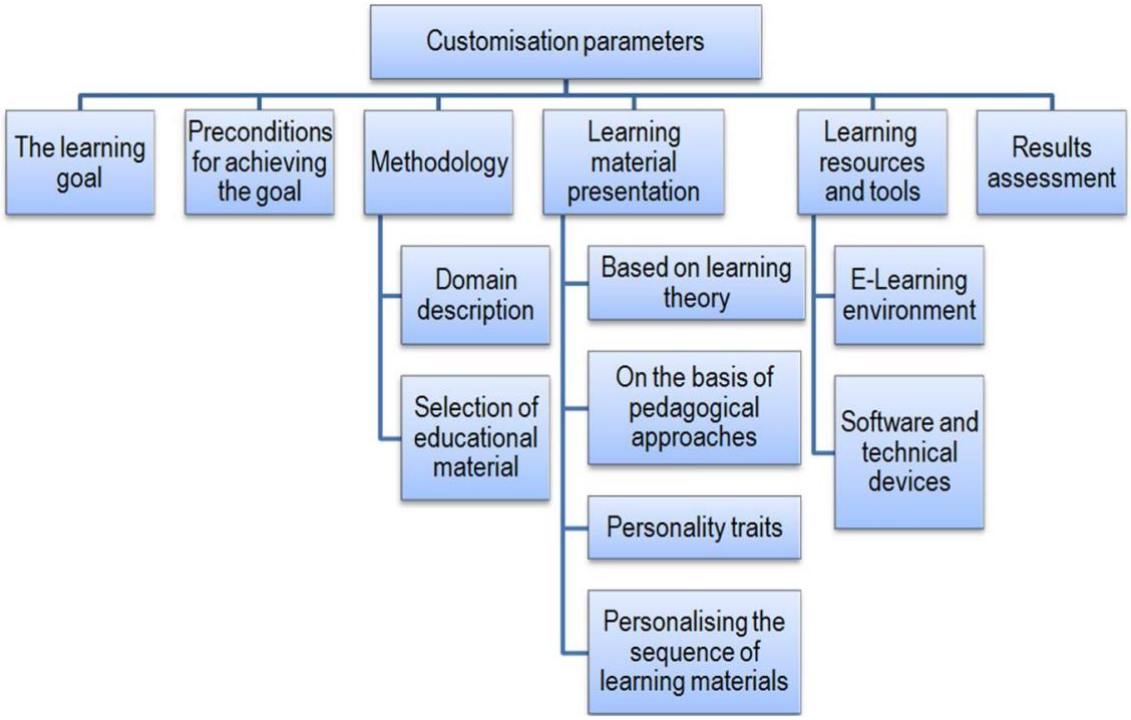

Figure 4. Customisation parameters taxonomy corresponding to the logic of the learning process

Goal parameters related to the individual differences of learners, are, for example: achievement of competencies; advanced training; ability to carry out any activity; compliance with standards (educational or professional). The list of preconditions for achieving the learning goals, which may include: motivation; the achievement level of the goal (e.g., bachelor's degree or a master's degree); initial level of educational attainment; and time allotted for training. Methods correspond to the studied subject area and are selected and structured in accordance with the goals and preconditions for learning. Presentation parameters describe the ways of presenting the learning material to the learner, for example, in what sequence, what level of difficulty, and in what form. Learning resources and tools are the functional capabilities of the learning environment and the technical means that the learner can or prefers to use. Results assessment parameters allow the evaluation of the achievements of the learner and characterise the degree to which the learner achieves the planned results, for example, the time spent by the student on mastering the learning material, their cognitive load, satisfaction, and skills.

Discussion of results

The results shown in Appendix A and Figure 3 indicate that the large number of educational resources and the variety of customisation parameters described in the literature make it necessary to develop customisation strategies applicable to a given course or student (e.g., Essalmi et al., 2015; Wan & Niu, 2018) that will help to choose the appropriate combination of customisation parameters. For this purpose, there are proposed, for example, systems which allow the selection of suitable parameters (Haddaji et al., 2017).

Analysing the obtained results, it was evident that a relatively small number of studies were devoted to the identification and formalisation of learning goals. There were even fewer publications on motivation for learning. None studied how the time allotted for learning and tempo of the student's work affected the customisation. The largest number of publications was devoted to the description of the subject area and the topic of how to teach. It should be noted that studies on the impact of learners' personalities dominated. This confirms the view that the main components of an individual educational trajectory are a set of training materials and their presentation to the student. However, it should be kept in focus that both of these components depend, on the one hand, on the learning goals and initial conditions, and on the other, on the available training tools, the capabilities of the e-learning system, or the gadgets used.

Forty-six different aspects of implementing a personalised educational trajectory were selected in the studied papers and grouped into six groups (Appendix A). Of course, in practice, there are many more, and there will be even more in the future. In addition, the number of combinations of these aspects becomes very large, which significantly complicates the task of creating an optimal educational trajectory. However, if we prioritise some parameters over others and determine their possible values, this allows us to develop recommendation systems for training with a high degree of variability in educational trajectories. The proposed taxonomy will help teachers to use customisation parameters in accordance with the stages of the training process and the goals of each stage when developing training courses.

The scientific community is yet to develop algorithms for the formation of individual educational trajectories that account for large numbers of parameters. In general, this is reduced to the selection of the learning materials and the schedule of its study. To implement customisation with a different set of parameters, specially designed information systems are required. The functional structures of those systems should be able to adapt the content and present it to the student both at the level of a single training module and at the level of the entire course being studied.

The purpose of this study was not to obtain a complete list of varying versions of grouping customisation parameters. The examples given sufficiently demonstrate the logic of the conclusions drawn. The lists can be supplemented, as new articles are published on other variants of the implementation of customisation methods.

Conclusion

In order to achieve the goal of this study, relevant publications on approaches to training customisation in academic disciplines, excluding highly specialised fields, were studied and analysed. Customisation parameters were analysed and the corresponding aspects of learning were identified. Customisation parameters were grouped according to the inner logic of the learning process. The main conclusions of the study are as follows:

1. E-learning environments tend to evolve towards adaptive hyper-media systems and advisory systems. Full deployment of the resources within the learner's personality to achieve their learning goals requires specially designed educational systems and methods for developing customisation strategies for training.
2. This research has contributed to the task of systematising customisation parameters. It has proposed the taxonomy of the customisation parameters corresponding to the logic of the learning process. The groups of customisation parameters were identified and their logical sequence was determined as: (a) goal parameters; (b) parameters determining preconditions for achieving the goal; (c) parameters defining methodology of personalised learning; (d) parameters that determine ways for presenting the learning material to the learner; (e) parameters depending on the capabilities of educational systems; and (f) parameters for assessing learner achievements.
3. The values of each parameter group depend on the values of the previous group, and this determines their sequence. Each of the proposed groups also consists of specific customisation parameters (Figure 3, Appendix A). This allows us to simplify the development of an individual learning trajectory corresponding to the learner's capacities and their learning goals.
4. No works that examined the learner's tempo of work and the time allotted for training as a parameter of customisation were found. For future research, these are important parameters, as time is a limited resource, which needs to be used effectively during the study process.

The main goal of this research was to identify ways to align the content of training courses in accordance with the expectations, learning goals, and capabilities of learners during the time scheduled for training and learning. For the future it is planned to further apply the proposed taxonomy and the logical sequence of its elements to develop individual schedules for students' development in academic disciplines. This study assists to fill the identified gaps in the use of allotted time for training and learning goals. It was discovered that the learning goals and allocated resources (the most important of which is time) determine the methods and forms of achieving these goals. In the future, these topics will be explored in more detail to show the relationships between customisation parameters presented in the developed taxonomy.

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Appendix A
Groups of customisation parameters in training and their components

Groups of customisation parameters in training	Aspects of learning process	Customisation parameters	Publications
The learning goal	Learning goals, learner's needs	Acquisition of competencies	Ford & Meyer, 2015 Gervais, 2016 Gonczi & Hager, 2010
		Advanced training	Judrups, 2015 Lau & Tsui, 2009
		Ability to carry out any activity	Peña-Ayala et al., 2014 Prins et al., 2016 Wikhamn, 2017
		Compliance with standards (educational or professional)	Laksitowening & Hasibuan, 2015
Preconditions for achieving the goal	Motivation, initial level of educational attainment, time allotted for training	Motivation	Backhaus et al., 2017 Birjali et al., 2018 Khamparia & Pandey, 2018
		Level of the goal's achievement	Khamparia & Pandey, 2018
		Initial level of educational attainment	Esichaikul et al., 2011 Khamparia & Pandey, 2018 Siddique et al., 2018
		Time allotted for training	No publications found
Methodology	Educational resources, domain description, set of learning materials, pedagogical approaches	Domain description: - Ontological representation	Cakula & Sedleniece, 2013 Cheng & Ma, 2016 Gayathri & Uma, 2018 Konys, 2018 Tarus et al., 2018

		- Knowledge maps	Balaid et al., 2016 Tang & Zhu, 2013
		- Knowledge management	Cakula & Sedleniece, 2013 Mustafa, 2018 Nunes et al., 2009
		- Petri nets	Cheng & Ma, 2016
		Selection of educational material: - Preferences and interests	An & Carr, 2017 Benhamdi et al., 2017 El Fazazi et al., 2018 Tsortanidou et al., 2017 Wan & Niu, 2018
		- Using a memetic algorithms	Acampora et al., 2011
		- Based on fuzzy logic	Almohammadi et al., 2017
		- Using collaborative filtering	Benhamdi et al., 2017 Bobadilla et al., 2009 El Fazazi et al., 2018 Klašnja-Milićević et al., 2015
		- By social media activity	Birjali et al., 2018 Klašnja-Milićević et al., 2015 Mahajan et al., 2016
		- Based on the difference between required and achieved	Hussey et al., 2011 Laksitowening & Hasibuan, 2015
		- At the request of organisations	Chunaev & Shikov, 2018
Learning material presentation	Speed of mental processing, learner's personality, form of presentation of the learning materials, sequence of learning	Based on learning theory On the basis of pedagogical approaches:	Mbendera et al., 2010

	materials, work load, complexity of the learning material.	- Design	Ghallabi et al., 2015 Goodyear, 2015 Gynther, 2016 Premlatha & Geetha, 2015
		- Self-training	Metcalfe & Kornell, 2005 Tullis & Benjamin, 2011
		- Blended learning	Bernard et al., 2014 Graham et al., 2013
		- Problem-based learning	Hmelo-Silver, 2004 Savery, 2006
		Personality traits: - Concentration and diligence	Athanasiadis et al., 2018 Backhaus et al., 2017 Goda et al., 2015 Khamparia & Pandey, 2018 Lin & Kao, 2018
		- Confidence	Backhaus et al., 2017 Goda et al., 2015
		- Level of educational attainment	Christudas et al., 2018 El Fazazi et al., 2018 Esichaikul et al., 2011 Gunathilaka, 2018 Khamparia & Pandey, 2018
		- Cognitive characteristics	Chang et al., 2014 Hay et al., 2017 Siddique et al., 2018
		- Learning styles	Christudas et al., 2018 Chrysoulas & Fasli, 2018

			Drissi & Amirat, 2016 Gunathilaka, 2018 Khamparia & Pandey, 2018 Özpolat & Akar, 2009 Siddique et al., 2018 Sweta & Lal, 2017 Truong, 2016 Tsortanidou et al., 2017
		- The behavioural patterns	Chovanak et al., 2018 Goda et al., 2015 Mahajan et al., 2016 Sweta & Lal, 2017
		- Learning curves	Glock et al., 2018 Lee, 2011 Mosheiov & Sidney, 2003
		- Personalising the sequence of learning materials Ant Colony Optimization algorithm	Birjali et al., 2018 Kurilovas et al., 2015
		- Genetic Algorithm	Chen, 2009 Christudas et al., 2018
		- Based on the difference between required and achieved	Hussey et al., 2011
		- Independent determination	Metcalfe & Kornell, 2005
		- The level of complexity of the training material	Blazheska-Tabakovska et al., 2017 Chen, 2009 Gunathilaka, 2018
		- Automated e-learning planning	Garrido et al., 2013 Ghallab et al., 2004 Sanchez Nigenda et al., 2018

Learning resources and tools	Learning environment	E-Learning environment	Bartuskova & Krejcar, 2016 Benhamdi et al., 2017 Caputi & Garrido, 2015 Essalmi et al., 2010 Haddaji et al., 2017 Klašnja-Milićević et al., 2015 Ouf et al., 2017 Somyürek, 2015 Wilson & Scott, 2017
		Software and technical devices	Khamparia & Pandey, 2018
Results assessment	Assessment of results, learner's satisfaction	Assessment of achievements	Day et al., 2017 Fahim et al., 2018 Guerrero-Roldán & Noguera, 2018 Pereira et al., 2015 Stödberg, 2012
		Time spent studying	Lammers et al., 2008 Lee, 2011 Lynch & Ghergulescu, 2017
		Measuring cognitive load	Brunken et al., 2003 Paas & Sweller, 2014 Tomas & Jessop, 2018
		The satisfaction of the student	Drozdova & Guseva, 2017 Misut & Pribilova, 2015
		Skills	Glock et al., 2018 Lammers et al., 2008
		Competencies	Guerrero-Roldán & Noguera, 2018
		Learner's pace of work	No publications found