

KNOWLEDGE WORKER AS A USER OF INTELLIGENT COLLABORATIVE EDUCATIONAL SYSTEM

Sabina Katalnikova

Riga Technical University, Latvia

Abstract. Education is integral part of every knowledge worker's activity during their whole life. While talking about lifelong education of knowledge workers, it is important to provide a possibility to study following an individual programme and, keeping into mind their own particular study aim, to test their newly acquired knowledge practically, to collaborate and learn from colleagues. In this regard development and application of intelligent collaborative educational systems gain great importance. This article has a threefold purpose: 1) to analyse the notion of knowledge worker, 2) to highlight its main traits and characteristics, 3) to offer a model of knowledge worker from the standpoint of a user of intelligent collaborative educational system. This theoretical study was based on an analysis of available literature sources and a summarizing of information. In order to illustrate the proposed model, extended semantic networks were applied and their brief description was given.

Keywords: collaborative education, extended semantic networks, intelligent collaborative educational system, knowledge worker.

Introduction

In relation to scientific and technological revolution, contemporary priority is transition from manufacture of goods to manufacture of services. Currently there is a particular demand for information and knowledge; scientific achievements have become the basis for economics. Thus, for a society that wishes to develop efficiently, it is of utmost importance to promote forming of knowledge workers as the creativity, knowledge and skills of such workers are regarded as a chance for organisations to survive in an ever more competitive and rapidly changing environment. There are many definitions of knowledge workers, but all the authors agree that knowledge workers are a significant and ever growing worker group.

Integral part of every knowledge worker's activity during their whole life is education. During the educational process one should not limit oneself with acquiring and mastering information only from the tutor. Experiments of psychologist Hermann Ebbinghaus (Germany) already in 1885 indicate that mechanic memorization of information is not a successful learning strategy

(Ebbinghaus, 1885). If any problems arise, students must be able to acquire new information by combining it with the existing knowledge with the intention to solve a particular issue. Moreover, tuition must be carried out in collaboration; students must learn to collaborate among themselves. Contemporary society comprises people that collaborate globally, therefore, students must be encouraged to work together, unite them (Nichols, 2017).

On the other hand, information and communication technology opportunities and capacity are constantly increasing, leading to a continuous increase in the volume and variety of service activity in any area, including education. Therefore, the concept of collaborative educational system has appeared in the modern society and is becoming increasingly important (Katalnikova & Novickis, 2017).

Similar problems are described in many articles: development of web-based collaborative e-learning systems (Novickis & Rikure, 2005), development of agent based intelligent tutoring systems (Lavendelis & Grundspenkis, 2010), classification of collaborative systems and key concepts of collaborative educational systems (Ivan et al., 2010), development of intelligent tutoring system based on knowledge workers personal knowledge management systems (Grundspenkis, 2011), studying the influence of collaborative self- and peer-assessment methods on the quality of students' structural knowledge (Anohina-Naumeica, 2017), implementation of interactive tutor robot to enhance collaborative e-learning system for science and technology education field (Tojo et al., 2018).

However, it should be noted that the problem of development of directly collaborative educational systems for knowledge workers considering a set of their attributes has not been paid attention it deserves in the scientific community (Katalnikova et al., 2016).

The purpose of this work is to investigate the notion of knowledge worker, to identify and classify its basic traits and characteristics, and to create an initial proposal for a model of knowledge worker as a user of intelligent collaborative educational system. This analysis will be used in author's future work for creating user model of this system that most fully reflects features of the knowledge worker and properties of the adult student. To achieve the goal of the work an analysis of available scientific literature was made and a summarizing of information was fulfilled.

Knowledge Workers

The term “knowledge workers” was introduced by Peter Ferdinand Drucker – a scientist, economist, pedagogue (USA), - in 1959 (Drucker, 1959) to characterize an ever growing number of workers who work mostly with information or apply knowledge. There are many definitions of knowledge

workers. In 2000 P. F. Drucker defined knowledge workers in the following way – they are persons who add value to company's products and services by using their knowledge (Drucker, 2000). Another definition is provided (Davenport, 2005): knowledge workers are workers with a high level of knowledge, education or experience, the main aim of their work is creating, distributing or adjusting knowledge. In the paper (Kappes & Thomas, 1993) it is declared: knowledge worker is such a worker who summarizes data/information from any source, increases the value of information, distributes products with added value to others; *ibidem*: knowledge worker complies with process that requires knowledge both from internal and external sources to create product that stands out with its content of specific information.

Knowledge workers can create and improve their technological knowledge or supervise their colleagues' technological knowledge (Toffler, 1991). Knowledge worker is the one who applies information technologies in fulfilling everyday tasks and who directly influences efficiency and productivity of work and work process (Awad, 1996). For knowledge workers intellectual work is more significant than physical effort during the action process (Flood et al., 2001). Workers who usually do not follow strictly set work fulfilment procedure, but apply their own creativity, knowledge and skills for business development (Miller, 2002).

The main peculiarities of a knowledge worker is the existence of general and special knowledge, capability to search, evaluate and process information, the ability to collaborate with other people that is reflected in knowledge exchange, the ability to formulate problems and search for solutions, widely understandable flexibility, the ability to organise their work and work of other workers, the ability to analyse and control the acquired results, readiness and motivation to learn (Figurska, 2010).

The new skills of a knowledge worker are not hand labour working skills. Mainly they are intellectual skills, as well as social skills including work organisation in a group.

P. F. Drucker indicated in (Drucker, 2006) that education is a highly significant source that can give society and economics the advantages of competitiveness and that can make knowledge worker productive. Such worker becomes the main investment and education – the most expensive investment. In the paper (Drucker, 1969) P. F. Drucker declares the necessity for new access to education – education must form universal skills that include application and systematic acquiring of knowledge as basis for efficiency, qualification and achievements. If there is knowledge applied during the work, life-long learning is necessary. Person must learn how to study and perform it independently, apply knowledge for acquiring skills, apply knowledge in practice. Educational system

must provide requalification of knowledge through the whole life (continuous education) and, thus, also workforce mobility.

The main characteristic that separates knowledge labour from other traditional types of labour is the fact that the basic task of knowledge labour is thinking. Although all the types of labour are related to blend of physical, social and mental labour, continuous processing of non-standard problems is carried out and it requires non-linear and creative thinking and also characterizes knowledge labour (Reinhardt et al., 2011).

Work organisation, analytical skills, motivation to learn, stress endurance, experience and teamwork are the most significant competences of creative knowledge workers that define their ability to perform creative work (Sokol & Figurska, 2017). Knowledge worker is a person who is usually strongly motivated to work well (Drucker, 1959) (Davenport, 2005). Research shows that the majority of knowledge workers are ready for self-governance, self-organisation and self-control (Mladkova, 2015).

Another difference of the work of the knowledge worker is the fact that it is not easy to assess the results or the productivity of the work as their work result is rarely particular or immediate, the results of knowledge work can differ from the standpoint of short-term and long-term perspective. Productivity of knowledge work cannot be measured in a way of manufactured units, it should be more regarded as quality of the result (Drucker, 1999). Knowledge work inheres unclear aims, processes or results, uncertain tasks (Spath, 2009), insufficient familiarization with methods that are necessary for attaining the aim or an unclear link between the method and the work results (Willke, 1998).

Knowledge workers frequently work in a team. Team members have mutually dependant tasks as they must share information or knowledge to obtain the necessary result or production (Van der Vegt et al., 2001).

To summarize the aforementioned definitions:

- the work of a knowledge worker is related to a large amount of information and ability to process and analyse it;
- the work of a knowledge worker requires continued education;
- knowledge workers are motivated to learn throughout their lives;
- the major part of the work to be fulfilled is intellectual work where knowledge is applied and created;
- the knowledge worker must inhere creative skills, ability to create new knowledge, fulfil unclear aims;
- knowledge worker produces nonmaterial product that is hard to evaluate;

- knowledge workers organise and supervise their own work, their work requires problem solving skills, great self-motivation and readiness for self-control;
- knowledge worker can work in a team, collaborate with colleagues, share knowledge, fulfil mutually dependant tasks.

Adult Education and Collaborative Educational Systems

American pedagogue Malcolm Knowles formulated six assumptions that separate an adult student to be (Knowles, 1990):

- self-appraisal – an adult strives for self-implementation, independence, self-governance, can create the studying environment themselves;
- experience – an adult has huge life experience that could be used as an ever greater resource for studies;
- the necessity to know – adults need to know why they require this knowledge before the studies begin; they do not study only to accumulate knowledge;
- the readiness to learn – the readiness of an adult for studies becomes more oriented to the tasks of social role development;
- motivation to learn – an adult's greatest motivation is internal: better quality of life, recognition, self-confidence;
- orientation to studies – an adult focuses one's attention to the particular aim and applies everything that has been acquired to achieve it, therefore, theoretical knowledge of an adult during the education process must be strongly related to actual practical activities.

Thus, when speaking about adult life-long learning it is important to provide the possibility to study following an individual programme keeping in mind their own study aim; practically test the newly acquired knowledge; collaborate and learn from colleagues.

It can be specially attributed to knowledge workers who have a big role in contemporary society, which must be creative, responsible, dynamic and communicable. Thus collaborative education becomes more and more significant.

Collaborative education can be defined as teaching environment where the students get involved with an intention to solve problems together (Teasley & Roschelle, 1993); situation when two or more people learn or try to learn something together (Dillenbourg, 1999); student common action method in a small group against the same aim (Prince, 2004).

The an idea of group work in education is rooted in the works of psychologist L. S. Vygotsky whose research on causal relationship between social interaction and individual learning created basis for social constructivism theory (Vygotsky,

1982) that defends application of collaboration instruments with an argument that cognitive development is a result of social interaction (Vygotsky, 1982) (Underwood, 2016). There is also research how this theory is available for application in educational technologies in contemporary digital age (Goldie, 2016) (Mattar, 2010). Research of many authors proved that education is more efficient if people collaborate and share ideas by solving the task as a group not as individuals, that knowledge formation in groups prevail individual learning (Johnson & Johnson 1989) (Bindley et al., 2009) (Muuro et al., 2014).

Collaborative education has fixed advantages as students actively collaborate with partners, use the acquired information for synthesis of new knowledge, works with several opinions of various people, learn to formulate and defend their opinion, find a substantiation for their judgement (Smith & MacGregor, 1992).

Collaborative educational systems, especially contemporary quickly developable intelligent collaborative educational systems (where artificial intelligence methods are applied for reflecting information, knowledge, decisions), are very good for tuition of knowledge workers particularly. As it was already mentioned, knowledge workers must continuously learn innovative knowledge to be competitive. It makes continuous tuition of workers one of the priorities of personal management functions in contemporary organisations. In this field a great problem is related to global virtual organisations the workers of which are spread all over the world and in this regard the tuition of knowledge workers takes place mainly as independent education.

Collaborative educational systems ensure also the strong link with industries that is so important nowadays. Preparation process of competent specialists cannot be separated from economical activities where such qualified specialists are necessary. And exactly collaborative educational systems provide such link as, on one hand, operation of such system is based on knowledge, promotes creation of new knowledge, acquisition of new competences, including social competences, and, on the other hand, does not require extended absence from the work place.

Model of User of Intelligent Collaborative Educational System

From the standpoint of intelligent collaborative educational system a knowledge worker can be viewed in three aspects:

- knowledge worker as basis – intelligent collaborative educational system is created by taking into account peculiarities and characterizations of these workers;

- knowledge worker as a process – the basis for operation of intelligent collaborative educational system – creation/improvement of knowledge worker;
- knowledge worker as a result – the aim and main result of operating an intelligent collaborative educational system – increase of knowledge worker’s competence.

The basis of intelligent collaborative educational system – self-dependent work of students, which is the leading type of tuition process organisation (see Figure 1).

Collaborative educational systems possess the following characteristics (Katalnikova & Novickis, 2017):

- the aim of the system is to provide students with adequate support in the process of problem solving as an instructor-human would have done;
- any system of collaborative education is based on a user (student) model, taking into account the set of characteristics of the adults as well as the current level of professional competence and knowledge;
- at the basis of studies, there is the underlying study programme based on the student characteristics and needs, the purpose of education and the required range of competencies;
- education is geared to the needs of employers;
- during studies, there are developed skills for the user to apply knowledge for specific practical tasks;
- self-motivation is of great importance in such systems;
- education takes place in collaboration, promoting equal partnership.
- The student’s model in educational systems consists of two types of characterizations of students:
 - static data that does not change during tuition;
 - dynamic data that changes constantly.

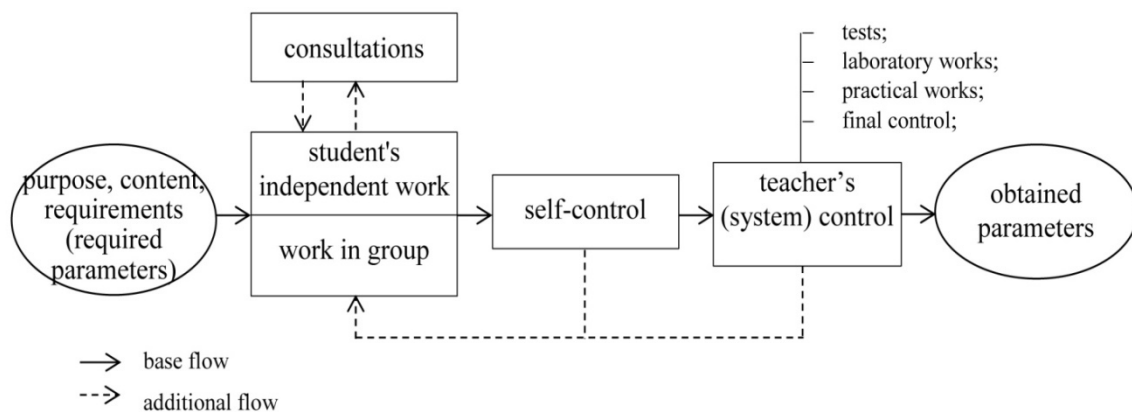


Figure 1. Chart of independent work within collaborative educational system

The basic data of student's model for intelligent collaborative educational systems, intended for tuition of knowledge workers, must be complemented with adult and especially knowledge workers characterizations. Thus, the data for student's model could be the following:

- static data, namely, common information, personal data, previous education, previous experience in the learnable field, preferences, interests, the purpose of the training, the planned tuition time, student's psychological characterizations, including knowledge worker's characteristic traits;
- dynamic data (student's development level), namely, the student's level of competency (knowledge on the learnable field), acquired study courses, student's evaluation during tuition, final evaluation.

For creation of knowledge worker's model for intelligent collaborative educational system (see Figure 2) extended semantic networks were applied that were offered in works of I. Kuznetsov (Russia) as improvement on semantic networks (Kuznetsov, 1986) (Kuznetsov, 2006). These networks can be applied for reflection of complex objects, logical, general information, several demands, dependences etc. In extended semantic networks the nodes correspond not only to objects or concepts, but also relations, logical components of information (facts of truth or untruth), complex objects etc. Everything that could be regarded as an independent unit must correspond to a separate node.

In such networks instead of edges of usual semantic networks, the so-called, link nodes are used. This node does not correspond to any object or relation, it is used only for indicating the link and provides equal relevance for nodes that correspond to separate components or units of information. As a result, a fragment is formed that corresponds to an elementary situation. The networks are constructed from such fragments.

This model makes the basis for operation of intelligent collaborative educational system that starts from the analysis of this model. In compliance with statistical data of this model and the knowledge (competence) level of the student, training groups are formed. Relation with industry is provided based on knowledge worker's previous experience and compliance with employer's requirements. Results of intelligent collaborative educational system operation, namely, the acquired competences that are confirmed with issued certificates, are evaluated based on dynamic data analysis of the student model.

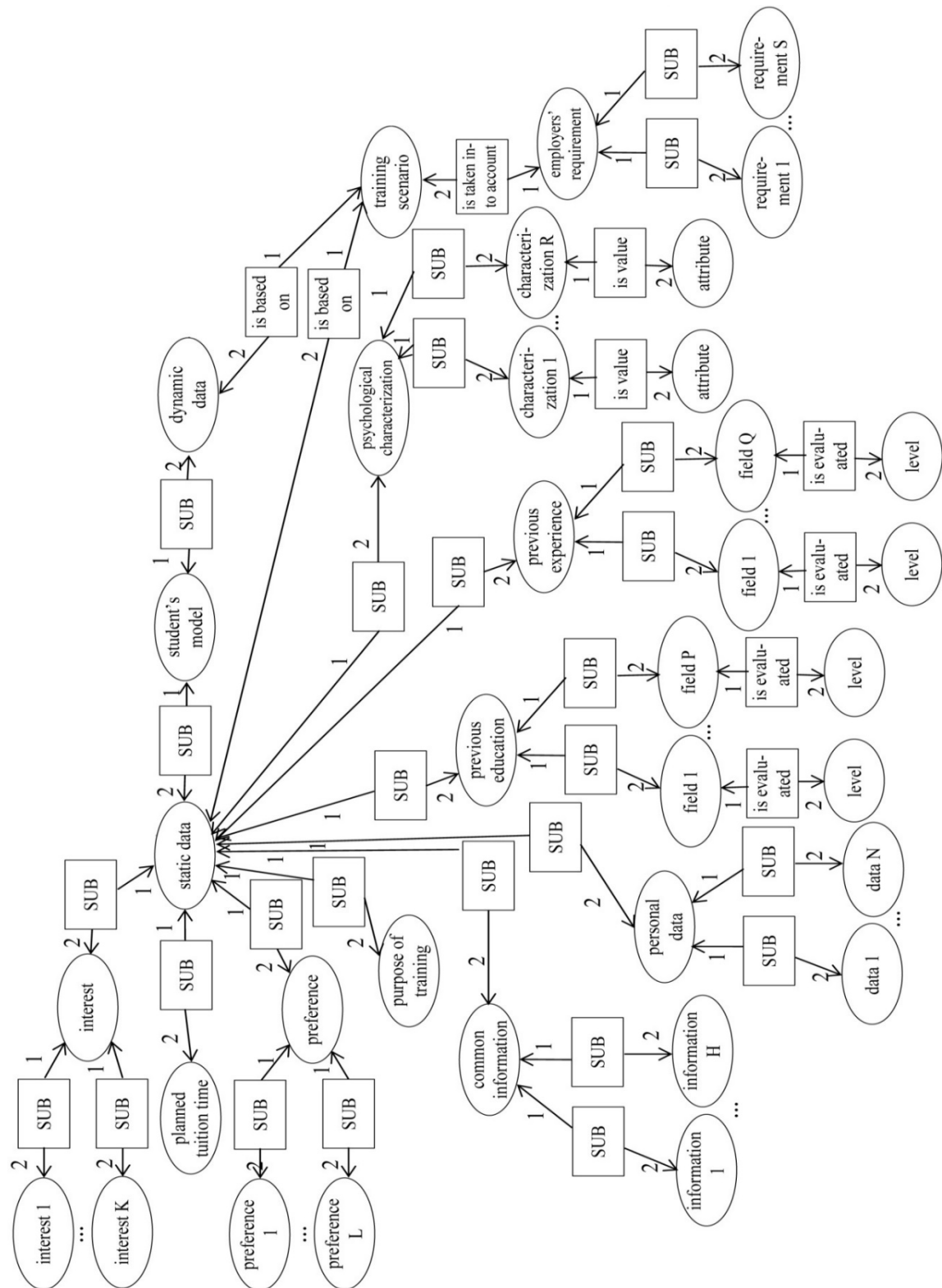


Figure 2. Fragment of model of a knowledge worker for intelligent collaborative educational system

Conclusion

In the offered paper the author tried to comprehensibly analyse the notion of knowledge worker and highlight the characteristic traits and peculiarities of the worker group with an intention to form a knowledge worker model for application in intelligent collaborative educational system. For the formation of the model extended semantic networks, which are improvement of semantic networks in logical and calculation aspects, were applied.

In the work particular characteristics of adult education and education in collaboration which play a huge role in contemporary dynamic, open and mobile information society were described.

References

- Anohina-Naumeca, A. (2017). Studying the Influence of Collaborative Self- and Peer-Assessment Methods on the Quality of Students' Structural Knowledge. *Proceedings of the 10th International Conference of Education, Research and Innovation*, 5979-5989.
- Awad, E. M. (1996). *Expert Systems*. Minneapolis, MN: West Publishing Co.
- Brindley, J., Blaschke, L. M., & Walti, C. (2009). Creating effective collaborative learning groups in an online environment. *The International Review of Research in Open and Distance Learning*, 10 (3). Retrieved from:
<http://www.irrodl.org/index.php/irrodl/article/view/675/1271>
- Davenport, T. H. (2005). *Thinking for a Living: How to Get Better Performance and Results from Knowledge Workers*. Boston: Harvard Business School Press.
- Dillenbourg, P. (1999). What do you mean by 'collaborative learning?' In P. Dillenbourg (Ed.), *Collaborative-learning: Cognitive and Computational Approaches* (1-19). Oxford: Elsevier
- Drucker, P. F. (1959). *Landmarks of tomorrow*. USA: Harper Business.
- Drucker, P. F. (1999). Knowledge-worker productivity: The biggest challenge. *California Management Review*, 41 (2), 79-94.
- Drucker, P. F. (2000). Managing knowledge means managing oneself. *Leader to Leader*, 16, 8-10
- Drucker, P. F. (1969). *The Age of Discontinuity: Guidelines to our Changing Society*. London: Heinemann
- Drucker, P. F. (2006). *The Effective Executive: The Definitive Guide to Getting the Right Things Done*. N.Y.: HarperCollins
- Ebbinghaus, H. (1885). *Memory: A Contribution to Experimental Psychology*. Leipzig: Duncker & Humblot. Retrieved from:
<http://psychclassics.yorku.ca/Ebbinghaus/index.htm>
- Figurska, I. (2010). Selected aspects of managing knowledge workers. *Human Resources Management & Ergonomics*, 4 (2), 18-30.
- Flood, P. C., Turne, T., Ramamoorthy, N., & Pearson, J. (2001). Causes and Consequences of Psychological Contracts Among Knowledge Workers in the High Technology and Financial Services Industries. *The International Journal of Human Resource Management*, 12 (7), 1152-1165. <https://doi.org/10.1080/09585190110068368>

- Goldie, J. G. (2016). Connectivism: A knowledge learning theory for the digital age? *Med Teach* 38 (10), 1064-1069. Retrived from: <https://www.ncbi.nlm.nih.gov/pubmed/27128290>
- Grundspenkis, J. (2011). The Conceptual Framework for Integration of Multiagent Based Intelligent Tutoring and Personal Knowledge Management Systems in Educational Settings. *Workshops on Business Informatics Research: International Workshops and Doctoral Consortium*, 143-157.
- Ivan, I., Ciurea, C., & Milodin, D. (2010). Collaborative Educational System Analysis and Assessment. *Third International Conferences on Advances in Computer-Human Interactions*, 160-165. doi: 10.1109/ACHI.2010.13
- Johnson, D. W., & Johnson, R. T. (1989). Cooperation and competition: Theory and research. *Edina, MN: Interaction Book Company*. Retrieved from: <http://www.cooperation.org/books-and-materials/>.
- Kappes, S., & Thomas, B. A. Model for knowledge worker information support. *Knowledge Worker Information Management*, 1-4.
- Katalnikova, S., & Novickis, L. (2017). Conceptual Model of Intelligent Collaborative Educational System: Possible Solutions. *International Journal of Computer Science and Information Security*, 15 (11), 123-128.
- Katalnikova, S., Novickis, L., & Prokofjeva, N. (2016) Knowledge Representation in Intelligent Collaborative Educational Systems. *CEUR Online Workshop Proceedings, 1684*, 1-10. Retrieved from: <http://ceur-ws.org/Vol-1684/>.
- Knowles, M. (1990). *The adult learner. A neglected species, 4th Edition*. Houston: Gulf Publishing Co.
- Kuznetsov, I. P. (1986). *Semantic Representation*. Nauka, Mockow (In Russian).
- Kuznetsov, I. P., & Matskevich, A. G. (2006). *Semantic-oriented Systems Based on Knowledge Bases*. Moscow: MTUSI (In Russian).
- Lavendelis, E., & Grundspenkis, J. (2010) MIPITS - An Agent based Intelligent Tutoring System. *Proceedings of 2nd International Conference on Agents and Artificial Intelligence*, 5-13.
- Mattar, J. A. (1982). Constructivism and connectivism in education technology: Active, situated, authentic, experiential, and anchored learning. *Technology*, 1-16.
- Miller, R. (2002). Motivating and Managing Knowledge Workers. *Knowledge Management Review*, 5 (1), 16-20.
- Mládková, L. (2015). Knowledge Workers and the Principle of 3S (Self-management, Selforganization, Self-control). *Procedia Social and Behavioral Sciences*, 181, 178-184. <https://doi.org/10.1016/j.sbspro.2015.04.879>
- Muuro, M. E., Wagacha, W. P., Kihoro, J., & Oboko, R. (2014). Students' perceived challenges in an online collaborative learning environment: A case of higher learning institutions in Nairobi, Kenya. *The International Review of Research in Open and Distributed Learning*, 15 (6), 132-161. doi: <http://dx.doi.org/10.19173/irrodl.v15i6.1768>
- Nichols, J. R. (2017). 4 Essential Rules Of 21st Century Learning. Retrieved from: <https://www.teachthought.com/learning/4-essential-rules-of-21st-century-learning/>.
- Novickis, L., & Rikure, T. (2005). Intelligent Tutoring Systems. *Proceedings of IST4Balt International Workshop "IST 6th Framework Programme – Great Opportunity for Cooperation & Collaboration"*, 35-40.
- Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education*, 93 (3), 223–231.

- Reinhardt, W., Schmidt, B., Sloep, P. B., & Drachsler, H. (2011). Knowledge Worker Roles and Actions - Results of Two Empirical Studies. *Knowledge and Process Management*, 18 (3), 150–174. doi: 10.1002/kpm.378
- Smith, B. L., & MacGregor, J. T. (1992). What is collaborative learning? In Goodsell, A., Maher, M., Tinto, V., Smith, B. L., & MacGregor J. T. (Eds.), *Collaborative Learning: A Sourcebook for Higher Education* (9-22). USA: Pennsylvania State University, National center on postsecondary teaching, learning, and assessment publishing.
- Sokol, A., & Figurska, I. (2017). Creativity as One of the Core Competencies of Studying Knowledge Workers. *The International Journal Entrepreneurship and Sustainability Issues*, 5 (1), 23-35. [http://jssidoi.org/jesi/http://doi.org/10.9770/jesi.2017.5.1\(2\)](http://jssidoi.org/jesi/http://doi.org/10.9770/jesi.2017.5.1(2))
- Spath, D., & Hofmann, J. (2009). The Knowledge Worker as a Resource – Productivity Potential of the 21st Century. In: *Gestaltungsfeld Arbeit und Innovation* (333-363). München: Rudolf Haufe Verlag [In German].
- Teasley, S. D., & Roschelle, J. (1993). Constructing a Joint Problem Space: The computer as a tool for sharing knowledge. In Lajoie, SP and Derry, SJ (eds), *The Computer as a Cognitive Tool* (229–258). Hillsdale, NJ, USA: Erlbaum.
- Toffler, A. (1991). *Powershift: Knowledge, Wealth, and Violence at the Edge of the 21st Century*. Bantam.
- Tojo, T., Ono, O., Noh, N. B. M., & Yusof, R. (2018). Interactive Tutor Robot for Collaborative e-Learning System. *Electrical Engineering in Japan.*, 203(3), 22-29. doi: 10.1002/ej.23073
- Underwood, Z. (2016). Connectivism: A Learning Theory for Today’s Academic Advising. *Academic Advising Today*, 52. Retrieved from: <http://www.nacada.ksu.edu/Resources/Academic-Advising-Today.aspx>.
- Van der Vegt, G. S., Emans, B. J. M., & Van de Vliert, E. (2001). Patterns of Interdependence in Work Teams: a Two-level Investigation of the Relations with Job and Team Satisfaction. *Personnel Psychology*, 5(1), 51–69. doi: 10.1111/j.1744-6570.2001.tb00085.x
- Vygotsky, L. (1982). *The Collected Works: Questions of Theory and History of Psychology*. M.: Pedagogika (In Russian).
- Willke, H. (1998). Organized Knowledge Work. *Zeitschrift für Soziologie*, 27 (3), 161–177. <https://doi.org/10.1515/zfsoz-1998-0301> (In German)