Digital-Pedagogy.eu Institute for Education

Journal of Digital Pedagogy

2024, Vol. 3, No. 1, pp. 11-17

ISSN 3008-2021

https://doi.org/10.61071/JDP.2447

Need, Advantages and Capabilities of Learning Analytics in K12 Education: Study Results from Lithuania

Gražina Šmitienė

Department of Pedagogy, Faculty of Social Sciences and Humanities, Klaipeda University

https://orcid.org/0000-0002-3604-7295

Julija Melnikova

Department of Pedagogy, Faculty of Social Sciences and Humanities, Klaipeda University

https://orcid.org/0000-0001-6078-6963

Aleksandra Batuchina

Department of Pedagogy, Faculty of Social Sciences and Humanities, Klaipeda University

https://orcid.org/0000-0003-0012-9421

Gita Šakytė-Statnickė

Faculty of Business, Klaipeda State University of Applied Sciences

https://orcid.org/0000-0002-5320-810X

Abstract: Learning analytics is identified as one of the essential prerequisites for ensuring the quality of learning for each student and is associated with wider opportunities for the organization of individualized, differentiated and personalized learning. One of the focuses - the individualization and personalization of natural science and mathematics education - is connected with one of the priorities of Lithuanian education, recognizing the need to develop students' mathematical, natural science and technological competences, and to foster a culture of innovation in schools. Although the importance of integrated education is recognized for the sustainable improvement of the student's natural science and mathematics competence, there are problems in solving the issues of integrated organization of natural sciences and mathematics in lessons, searching for the most appropriate didactic solutions at the student and class levels. The usefulness of learning analytics in modern education is not in doubt internationally, but the approach to it in educational practice is quite ambiguous: the search for tools of learning analytics, the system of its use, definitions of advantages for the learner – these are the questions that raise researchers' attention. It is recognized that the Lithuanian scientific discourse of the use of learning analytics in science and mathematics education contains little research,

Received: 10.04.2024. Accepted: 19.04.2024

Citation:

Šmitienė, G., Melnikova, J., Batuchina, A., Šakytė-Statnickė, G. (2024). Need, Advantages and Capabilities of Learning Analytics in K12 Education: Study Results from Lithuania. *Journal of Digital Pedagogy, 3*(1) 11-17. Bucharest: Institute for Education. https://doi.org/10.61071/JDP.2447

examples of pedagogical practice that analyse the possibilities of digital platforms with artificial intelligence and learning analytics tools are scarce.

This qualitative study was particularly sought to disclose the possibility of using learning analytics in the science education and math lessons. Focus group participants were teachers and students from general education schools in Lithuania who, in September – December 2021, participated in a project dedicated to the testing of learning analytics tools in science education and mathematics classes. The aim of the investigation was to extract the accumulated experience of teachers and students in working with digital platforms and in applying learning analytics based on artificial intelligence. The results of the study revealed that teachers and students have no doubts about the advantages of digital platforms integrating learning analytics based on artificial intelligence, in identifying student (class) learning gaps, learning characteristics, making data-based decisions regarding differentiation and individualization of learning. Research participants saw the importance of data generated by learning analytics in planning and organizing integrated math and science education lessons.

Keywords: Learning Analytics, Science Education, Mathematics Lessons

Introduction

In recent years, the issue of digitization of education has become more relevant for EU countries in general and Lithuania in particular. The COVID-19 pandemic situation accelerated digitalization, in result, digital technologies have become part of the teaching/ learning process. Moreover, the use of technologies has been proven to be crucial in ensuring better education for learners during a pandemic. Therefore, both schools and teachers have to ensure continuity of education provision and quickly respond to the new teaching and learning scenarios (Cabero-Almenara, 2020; Rupšienė et al., 2021).

The recent trend in digitalisation of education has fostered the rapid development of educational technologies such as computer-based learning environments, adaptive learning technologies, intelligent learning systems, "smart classrooms" and other. These technologies generate a lot of data about learners.

In the scientific literature, the pursuit of using teaching and learning data to improve teaching and learning is defined as learning analytics (Long et al., 2011; Romero, Ventura, 2013). Learning analytics is used in the classroom for a variety of purposes: monitoring and analyzing student learning, learning prognostication, planning teaching and learning activities, personalization, assessment and feedback, etc. (Vourikari, Munoz, 2016; Chatti, Dyckhoff, Schroeder, Thüs, 2012; Moissa, Gasparini, Kemczinski, 2015; Pineda, Cadavid, 2018). The opportunities of learning analytics namely: to provide recommendations for individualized learning (helping the learner to create his own learning path), to help the teacher provide recommendations for further learning or to provide recommendations to the learner himself, are widely presented and have been proved as a means of effective tracking of personal learning progress (Pineda and Cadavid, 2018).

The relevance and benefit of the application of learning analytics for education is also evidenced by the fact that in recent years, an increasing number of digital tools, both commercial, such as: MS Teams, Google Classroom, iSpring Learning, etc., and open source, such as Moodle, etc., intended for various educational sectors, includes data analysis technologies. For learning improvement purposes, learning analytics technologies are integrated into digital education tools or digital learning programs, e.g. Eduten Playground (for teaching mathematics etc.)

Digital teaching and learning platforms based on artificial intelligence and integrating learning analytics provide teachers with the insights needed to make decisions about: improving classroom instruction (Long, Siemens, 2011); on the personalization of training (in order to enable the learners themselves to design their own learning according to how they learn, what learning needs they have) (Mangaroska et al., 2019, Ifenthaler et al., 2020); for effective feedback organization (real-time, reasonable and more effective feedback) (Weber, 2015); regarding the quality of education in order to reduce exclusion, identify groups of students at risk (Kurvinen et al., 2020, Mangaroska and Giannakos, 2018). In order to make these and other decisions in the classroom, it is necessary for the teacher to properly collect and process data, and have enough time to perform these actions. In turn, the data generated by learning analytics tools allows the teacher to: assess the strengths or weaknesses of students' learning much faster, the characteristics of each student's engagement in learning activities in real time (Pardo et al., 2016); consistently see changes in learning activities (knowledge, abilities), make decisions that promote their learning (Admiraal et al., 2017); to critically review the teaching/learning information presented to the students, to correct it (Mouri et al., 2018).

On the one hand, learning analytics tools integrated in digital platforms provide opportunities for teachers to successfully expand, complement teaching and learning in the classroom with virtual environments, use advanced learning environments in lessons (Yacobson et al., 2021; Van Leeuwen et al., 2021), achieve learning quality by reducing differences in student learning (Kurvinen et al., 2020), to individualize and differentiate teaching and learning (Mangaroska et al., 2019). However, the success of using learning analytics tools in schools (lessons) depends on how teachers see the advantages of learning analytics digital tools and how they use them (Mayer, 2019; Zhu, Urhahne, 2018; Scherer et al., 2019). Little is known about how mathematics and science teachers in Lithuanian general education schools value the use of learning analytics tools in their lessons, what are their experiences in teaching mathematics, science (physics, chemistry, biology) in school and decision-making based on learning analytics data. The purpose of this study is to find out for what purpose and how science and mathematics teachers use digital platforms based on artificial intelligence and integrating learning analytics in their lessons.

The Research Design

During the implementation of the project "Artificial intelligence in schools: scenarios for the development of learning analytics in the modernization of general education in Lithuania" (no. S-DNR-20-4) focus group interviews with different groups of teachers were conducted. During the research, it was found that Lithuanian general education schools use the following platforms that integrate learning analytics and artificial intelligence: EdutenPlayground, Matific, Fast ForWord, Egzaminatorius.LT, EduAI (Baziukė, Girdzijauskienė, Norvilienė, 2021). The teachers who participated in the project used the LearnLab digital learning platform in their classes. This article presents a part of a study aimed at revealing the experiences of science and mathematics teachers in using learning analytics in the teaching and learning process.

Table 1

Focus group participants

Focus interview no.	Number of participants during the interview + 1 moderator	Duration of the interview
1	5 (2 science and 3 mathematics teachers)	2 hrs 20 min
2	4 (1 science and 3 mathematics teachers)	2 hrs
3	3 (1 science and 2 mathematics teachers)	2 hrs

In order to find out for what need and how science education (physics, chemistry, biology) and mathematics general education schoolteachers use digital teaching/learning platforms integrating learning analytics tools in their subject lessons, a qualitative research methodological approach was applied. A qualitative methodology was used in this research, as it gives a holistic, in-depth understanding of participants' experiences in real-world contexts, and provides access to what these experiences mean to them (Denzin, Lincoln, 2018). This methodology was used by adopting a constructivist-interpretivist approach. According to this approach, participants construct meanings in interaction with their context. The researcher can uncover the subjective meanings that participants give to their experiences by interacting with them (Denzin, Lincoln, 2018; Merriam, Tisdell, 2016). As in other qualitative studies (Creswell, Poth, 2018), focus group interviews were used as the data collection method. The choice of this method was based on the desire to understand and explain the meanings, beliefs and experiences that influence the feelings, attitudes and behavior of individuals (Wilkinson, 2004; Nyumba et al., 2018). The study was conducted in September - November 2021.

To achieve the purpose of the research, three focus group discussions were conducted with the same group of informants, i.e. as science and mathematics teachers in 2021, who participated in the project dedicated to the development of learning analytics in general education and who worked with learning analytics in the lessons of their subject (Eduten, LearnLab). The teachers represented different school communities (8 schools), different mathematics and science education subjects (physics, chemistry, biology), had various experiences in using learning analytics tools, all teachers worked with general education school students. The choice of teachers with different experiences was

determined by the desire to find out the opinions and ideas of those working in different schools, to see common patterns in their experiences. All science education and mathematics schoolteachers involved in the project participated in the focus group discussions (see table Nr 1). 12 teachers (science education (4 teachers), mathematics (8 teachers) with more than 5 years of experience and work experience with digital teaching and learning platforms that integrate artificial intelligence and learning analytics participated in the study.

The research was conducted in accordance with the principles of respect and impartiality, as well as the confidentiality of the discussion. Consent (written) from study participants to participate in the study was obtained (Rodham and Gavin, 2006; Sim and Waterfeld, 2019). Science and mathematics teachers were informed in advance (in writing) about the purpose of the study and the anonymity of participation. The teachers gave their consent in advance to participate in the study and to record the discussion. The recordings of the focus group discussions are used only for the purposes of data analysis and are stored on the media of the project researchers. The changed names of the informants (M - Mathematics, S-Science) are indicated when the interview quotes are presented in the research results section.

Results of the Study

When analysing the research data, 3 discussion topics of the focus group of science education and mathematics teachers were distinguished (see table Nr. 2): the purpose of using digital platforms integrating learning analytics; the advantages of learning analytics in learning science and mathematics; learning analytics capabilities of integrating science education and mathematics.

The need of using digital platforms integrating learning analytics

By using learning analytics in mathematics and science education classes, teachers first of all aim to determine the learning achievements of students (or each student): "I use learning analytics to find out where students have gaps" (M); "It is very important for me to know what and how much the students have understood" (M); "<...> platform made it possible to reveal the potential of every student, clear and detailed analytics made it possible to see everyone's successes and obstacles" (M); "<...> what the students do well, what doesn't, what should be paid attention to in other lessons" (S). The following issues as learning gaps, students' lack of knowledge and ability to apply knowledge, the situation in the classroom, are the focus of teachers' attention in order to make the most appropriate decisions regarding the organization of teaching in the classroom, the selection and preparation of learning materials. Digital platforms with integrated learning analytics take away a lot of routine teacher activities, allowing mathematics and science teachers to focus more on reviewing learning content and preparing educational tasks.

In analysing the research data, it became clear that in the schools that participated in the study, the use of learning analytics tools in science and mathematics lessons is a priority for identifying gaps in students' learning, teachers aim to assess which subject topics and at what level students know and understand, for which students and what problems of knowledge application have arisen, what skills important for learning (mathematics, physics, chemistry, biology) do the students lack. Equally important for teachers is the ability to differentiate and individualize teaching and learning in classes, to be able to differentiate tasks in classes, to make timely decisions about individual learning problems: "These data (generated by digital platforms) allow us to get to know students better not only according to their knowledge, but also according to their mathematical abilities" (M). "And this allows for proper differentiation and individualization of teaching in the classroom" (S). General abilities are important for teachers and students (ability to cooperate, teach to learn, think critically, etc.). The participants of the discussion noted the advantages of learning analytics in selecting learning tasks for students, the possibility to perform them at an individual pace on digital platforms.

The advantages of learning analytics in learning science and mathematics

Mathematics and science teachers emphasized the advantages of digital teaching and learning platforms based on artificial intelligence and integrating learning analytics tools for the student (groups of students). Even, though, research have showed only some teachers see the benefits of artificial intelligence and integrating learning analytics programmes and often these are the teachers who have a good understanding of how the programme works.

Meanwhile, there is a proportion of teachers using these programmes, but are interested in the programme because of the direct pedagogical benefits for the students, their interest, the improvement of their achievement and so on. In science and mathematics lessons, digital learning tools help not only to personalize and individualize learning content, but also to motivate students to engage in active learning outside of school: "<...> students willingly solve problems at home" (M); "<...> students after classes even spent several hours preparing assignments and discussing among themselves which they presented in class" (M). Students' involvement in learning, their motivation to learn mathematics and natural sciences were singled out as important conditions for ensuring learning results, which are implemented by including virtual learning environments in the teaching process.

In order to ensure deep learning of students in mathematics and science classes, it is important to: "create opportunities to choose an individual learning pace" (S), "help each learner to fully understand and delve into a new topic" (M), "consolidate new knowledge and abilities "(M). Digital teaching and learning platforms with artificial intelligence and learning analytics tools help implement deep learning in the classroom. On the other hand, comprehensive training is also important for ensuring learning success, i.e. students' not only intellectual, but also emotional involvement in a new topic. When learning both natural sciences (physics, chemistry, biology) and mathematics, the individual or group tasks presented on digital learning platforms allow the student(s) "to search and find original ways of performing the task" (S), "to discover the contexts of the newly studied topic and construct their own understanding" (S).

In the digital platform for learning mathematics, great attention is paid to the game elements of tasks: the teacher can assign tasks of different complexity (number of them) individually and to the whole class, which must be completed in order to get a reward (winning the game); tasks are rich in animation elements. These digital platforms, which integrate learning analytics tools, provide opportunities for teachers and students to individualize the tasks of mathematics education, help the student (s) to experience success in performing tasks that are suitable for him/her, increase students' confidence in their own abilities, and motivate them for further learning.

Learning analytics capabilities of integrating science education and mathematics

By sharing their experiences using learning analytics tools in mathematics and natural sciences (physics, chemistry, biology) classes, teachers identified new opportunities for integrated learning. Teachers singled out the possibilities of learning analytics and collaboration by preparing joint (integrated) lessons or integrating the tools of the same digital platform into separate educational subjects in order to achieve synergy of teaching and learning.

A clear trend has been observed – in classes of different subjects (mathematics and natural sciences) using the same digital learning analytics tools, together with colleagues to analyse and interpret students' learning data: „together we see the data provided about the same students, their diligence, responsibility" (S). ; „we reviewed student learning data together and discuss how we see learning in our lessons" (M); „while analysing the data together, attention is paid to students who do better/worse in the next lesson" (S). The participants of the discussion said that by analysing the data together, new ideas for the organization of integrated teaching/learning emerge: „we decided to use the same digital tools in our lessons so that students could pay more attention to deepening the topic, learn collaboratively" (S); „together we saw what general abilities the class has the strongest and after choosing a common topic, we looked for the most suitable methods" (M). The teachers, while presenting their common (science education, mathematics) experience in organizing integrated education, emphasized that joint analysis of learning analytics data was important for the initiation, planning and implementation of joint activities, the opportunity to analyse and interpret the same student learning data together with colleagues, to pay attention to different educational subjects emerging teaching and learning issues. When the teachers analysed the results of the integrated lessons and the students' reflections, it was noticed that the joint decisions on planning and organization of learning made based on the learning analytics data were more effective, had a greater impact on the students than the teachers would have expected in individual lessons, the students' reflections showed not only the positive emotional involvement of the latter in the learning activities, but also better learning results, as evidenced by learning analytics data.

Implications

The results of the focus group discussion of science education and mathematics teachers on the need of using digital teaching and learning platforms integrating learning analytics in lessons revealed that the priority need of learning analytics lessons is to identify and record students' learning achievements, knowledge and skill gaps in a timely manner. The analysis of student(s) learning presented on digital platforms based on artificial intelligence and integrating learning analytics allows teachers to make the most appropriate decisions regarding the organization of teaching in lessons: to differentiate and individualize teaching(s), to consistently develop students' general competencies.

Table 2

Needs, advantages, and capabilities of integrating science education and mathematics

Needs	**Advantages**	**Capabilities of integrating science education and mathematics**
Identification of gaps	Tasks of different complexities	Use of same digital tools
Identification of student‘s potential	Gamification	Joined pedagogical decisions
Differences of students’ achievements level	Individualization of the tasks	Greater impact on the students learning process
Lack of knowledge and ability to apply the knowledge	Differentiation and integration of subjects	Creation of positive emotional involvement
Proper differentiation and individualization of teaching	Joint analysis of the achievements	Evidence of the students’ results is data based.
	Individualisation of tasks	

The results of the discussions highlighted the advantages of learning analytics tools for the student(s): learning analytics tools allow students to see personal progress; receive tasks assigned to them individually; collaborative learning; engage (intellectually and emotionally) in learning activities; learn not only in class.

An important criterion for the integration of mathematics and science education lessons is the use of the same learning analytics tools, the joint work of teachers in analysing the strengths and weaknesses of students' learning, searching for the best learning opportunities, and making similar or different lesson organization decisions by consensus. The participants of the discussion also noticed the synergistic possibilities of learning analytics in organizing integrated mathematics and science education. The results of the conducted research do not allow making generalized conclusions suitable for the whole of Lithuania, but the research results revealed that the development of learning analytics application models and the analysis of their effectiveness are important directions for further research.

Bibliography

Admiraal, W., van Vugt, F., Kranenburg, F., Koster, B., Smit, B., Weijers, S., & Lockhorst, D. (2017). Preparing pre-service teachers to integrate technology into K–12 instruction: evaluation of a technology-infused approach. *Technology, Pedagogy and Education, 26*(1), 105-120. https://doi.org/10.1080/1475939X.2016.1163283

Baziukė, D., Girdzijauskienė, R., & Norvilienė, A. (2021). Dirbtinis intelektas ir mokymosi analitika bendrojo ugdymo mokyklose naudojamose skaitmeninėse mokymo (si) priemonėse: Lietuvos atvejis. *Computational science and techniques.*

Cabero-Almenara, J., & Llorente-Cejudo, C. (2020). Covid-19: transformación radical de la digitalización en las instituciones universitarias. *Campus virtuales, 9*(2), 25-34.

Chatti, M. A., Dyckhoff, A. L., Schroeder, U., & Thüs, H. (2012). A reference model for learning analytics. *International Journal of Technology Enhanced Learning, 4*(5-6), 318-331. http://dx.doi.org/10.1504/IJTEL.2012.051815

Denzin, N. K. (2018). The qualitative manifesto: A call to arms. Routledge.

Ifenthaler, D., Gibson, D., Prasse, D., Shimada, A., Yamada, M. (2020) Putting learning back into learning analytics: actions for policy makers, researchers, and practitioners. *Education Tech Research Dev.* https://doi.org/10.1007/s11423-020-09909-8

John, W., Creswell, P., & Poth, C. N. (2018). Qualitative inquiry and research design: Choosing among five approaches. Sage.

Kurvinen, E., Kaila, E., Laakso, M. J., & Salakoski, T. (2020). Long-term effects on technology enhanced learning: The use of weekly digital lessons in mathematics. *Informatics in Education*.

Kurvinen, E., Kaila, E., Laakso, M. J., & Salakoski, T. (2020). Long term effects on technology enhanced learning: The use of weekly digital lessons in mathematics. *Informatics in Education*.

Long, P., Siemens, G. (2011). Penetrating the Fog: Analytics in Learning and Education. *EDUCAUSE Review. 5.* 30-32. https://doi.org/10.17471/2499-4324/195

Mangaroska, K., & Giannakos, M. (2018). Learning analytics for learning design: A systematic literature review of analytics-driven design to enhance learning. *IEEE Transactions on Learning Technologies, 12*(4), 516-534.

Mangaroska, K., Vesin, B., & Giannakos, M. (2019, March). Cross-platform analytics: A step towards personalization and adaptation in education. In *Proceedings of the 9th international conference on learning analytics & knowledge* (pp. 71-75).

Mangaroska, K., Vesin, B., Giannakos, M. (2019). Cross-platform analytics: A step towards personalization and adaptation in education. *Proceedings of the 9th international conference*, 2019.

Mayer, R. E. (2019). Computer games in education. *Annual review of psychology, 70*, 531-549. https://doi.org/10.1146/annurev-psych-010418-102744

Merriam, S. B., & Tisdell, E. J. (2016). Designing your study and selecting a sample. *Qualitative research: A guide to design and implementation, 67*(1), 73-104.

Moissa, B., Gasparini, I., & Kemczinski, A. (2015). A systematic mapping on the learning analytics field and its analysis in the massive open online courses context. *International Journal of Distance Education Technologies (IJDET), 13*(3), 1-24. http://dx.doi.org/10.4018/IJDET.2015070101

Mouri, K., Uosaki, N., & Ogata, H. (2018). Learning analytics for supporting seamless language learning using e-book with ubiquitous learning system. *Journal of Educational Technology & Society, 21*(2), 150-163.

Nyumba, T., Wilson, K., Derrick, C. J., & Mukherjee, N. (2018). The use of focus group discussion methodology: Insights from two decades of application in conservation. *Methods in Ecology and evolution, 9*(1), 20-32. https://doi.org/10.1111/2041-210X.12860

Pineda, A. F., & Cadavid, J. M. (2018). A systematic literature review in Learning Analytics. In *Workshop de Ciência de Dados Educacionais (WCDE)*, Anais, CBIE 2018 (pp. 1-10).

Rodham, K., & Gavin, J. (2006). The ethics of using the internet to collect qualitative research data. *Research Ethics, 2*(3), 92-97.

Romero, C., Ventura, S. (2013). Predicting students' final performance from participation in on-line discussion forums. *Computers & Education, 68*, 458-472. http://dx.doi.org/10.1016/j.compedu.2013.06.009

Rupšienė, L., Škėrienė, S., Girdzijauskienė, R., & Pranckūnienė, E. (2021) Dirbtinio intelekto ir mokymosi analitikos plėtra mokyklose: scenarijai ir rekomendacijos. *Klaipėdos Universiteto leidykla*

Wilkinson, S. (2004) Qualitative research: Theory, method, and practice, 2004

Yacobson, E., Fuhrman, O., Hershkovitz, S., & Alexandron, G. (2021). De-identification is Insufficient to Protect Student Privacy, or–What Can a Field Trip Reveal?. Journal of Learning Analytics, 8(2), 83-92. https://doi.org/10.18608/jla.2021.7353

Zhu, C., & Urhahne, D. (2018). The use of learner response systems in the classroom enhances teachers' judgment accuracy. *Learning and Instruction, 58*, 255-262. https://psycnet.apa.org/doi/10.1016/j.learninstruc.2018.07.011