USING LEARNING ANALYTICS IN MATHEMATICS AND SCIENCE EDUCATION LESSONS: A CASE STUDY FROM LITHUANIA

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ABSTRACT
Learning analytics is associated with wide opportunities for the organisation of individualised, differentiated and personalised learning. Moreover, the individualisation and personalisation of natural science and mathematics education are considered one of the priorities of Lithuanian education, in order to foster a culture of innovation in schools. The importance of integrated education is recognised for the sustainable improvement of the students' competencies: problems in solving issues of the integrated organisation of natural sciences and mathematics in lessons, searching for the most appropriate didactic solutions, and so on. The usefulness of learning analytics is quite ambiguous: the search for tools for learning analytics, the system of its use, and definitions of benefits for the learner, are questions that require researchers' attention. The current article is based on a qualitative study that particularly sought to disclose the possibility of using learning analytics in science and maths lessons. Focus group participants were teachers from general education schools in Lithuania. The aim of the focus group was to extract the accumulated experience of teachers in working with digital platforms and applying learning analytics based on artificial intelligence. The results of the study revealed that teachers have no doubt about the benefits of digital platforms integrating learning analytics based on artificial intelligence, in identifying student (class) learning gaps, and learning characteristics, and making data-based decisions regarding the differentiation and individualisation of learning. The research participants saw the importance of data generated by learning analytics in planning and organising integrated maths and science education lessons.
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Introduction

In recent years, the digitalisation of education has gained increasing relevance across EU countries including Lithuania. The Covid-19 pandemic accelerated the digitalisation process in Lithuanian schools, making digital technologies an indispensable component of the teaching-learning process (Rupšienė et al., 2021). The use of technology has been recognised as crucial in ensuring coherent education for learners during the pandemic highlighting its transformative impact (Stankevičienė, 2024). According to researchers, the advent

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of digitalisation inevitably necessitates significant changes in forms, methods, roles and interactions in the teaching-learning process (Sampson et al., 2018; Sarker et al., 2019; Hollman et al., 2019). As educators and learners navigate this transition, they must adapt quickly to new teaching and learning scenarios brought about by digital technologies to maintain the quality and continuity of education (Cabero-Almenara, 2020; Rupšienė et al., 2021).

The recent trend in the digitalisation of education has spurred the rapid development of educational technologies, including computer-based learning environments, adaptive learning technologies, intelligent learning systems, 'smart classrooms', and others. These advancements generate vast amounts of data about learners (HarCarmel, 2016). The data collected during the learning process falls within the domain of learning analytics. Academic literature defines learning analytics as 'the collection, analysis, and reporting of data about students and their contexts to understand and optimise learning and the environment in which it occurs' (Long et al., 2011). This definition underscores the goal of learning analytics: to utilise data comprehensively to enhance education (Long, Siemens, 2011). Learning analytics offers immense potential for improving educational outcomes by leveraging insights gleaned from student data. By analysing patterns, trends and correlations within the data, educators can gain deeper insights into the learning behaviours, preferences and needs of students. This information enables them to tailor instructional strategies, interventions and support mechanisms to better meet the diverse needs of learners (Romero, Ventura, 2013).

Learning analytics serves a multitude of purposes in the classroom, including monitoring and analysing student learning, forecasting learning trajectories, planning teaching-learning activities, personalising instruction, and facilitating both summative and formative assessment and feedback (Chatti et al., 2012; Moissa et al., 2015; Pineda, Cadavid, 2018). These functionalities empower educators to gain deeper insights into students' progress, strengths and areas for improvement, thereby enhancing instructional effectiveness. One particularly powerful aspect of learning analytics is its ability to enable personalised learning experiences. By leveraging data-driven insights, teachers can provide tailored recommendations for individualised learning, assisting learners in crafting their own unique educational paths. This personalised approach acknowledges the diverse learning styles, preferences and paces among students, fostering a more inclusive and effective learning environment. Research by Pineda and Cadavid (2018) has demonstrated the efficacy of personalised learning recommendations in effectively tracking individual learning progress, underscoring its potential to optimise student outcomes.

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

On one hand, learning analytics tools integrated into digital tools and platforms offer teachers opportunities to expand and enhance classroom instruction (Yacobson et al., 2021; Van Leeuwen et al., 2021), improve learning quality by addressing differences in student learning (Kurvinen et al., 2020), and customise teaching and learning experiences (Mangaroska et al., 2019). On the other hand, the successful utilisation of learning analytics tools in schools depends on how teachers and students perceive the benefits of these digital tools and how effectively they integrate them into their teaching-learning practices (Mayer, 2019; Zhu, Urhahne, 2018). Furthermore, the capabilities offered by artificial intelligence-based learning analytics tools are reshaping forms, methods and roles within the teaching and learning process, fostering differentiation, individualisation, personalisation, and more (Ifenthaler et al., 2020). Digital learning platforms integrating learning analytics based on artificial intelligence lay the groundwork for more flexible teaching and learning approaches. Additionally, teachers can make data-informed pedagogical decisions that enhance their teaching practices, while students gain an insight into their own achievements and progress, empowering them to take greater responsibility for their learning journey (Admiraal et al., 2017; Ifenthaler et al., 2020).

There is currently a limited understanding of how mathematics and science teachers in Lithuanian general education schools perceive and utilise learning analytics tools in their classrooms, as well as their experiences of teaching mathematics, physics, chemistry and biology, and making instructional decisions based on learning analytics data. Therefore, the aim of this study is to explore and analyse the accumulated experiences of teachers in working with digital platforms and applying learning analytics based on artificial intelligence. By investigating teachers' perspectives and experiences, this study seeks to uncover valuable insights into the challenges, benefits and effective strategies for integrating learning analytics tools into classroom instruction. The findings of this study can inform the development of evidence-based strategies and policies to support the effective integration of learning analytics tools in educational practice, improving student learning experiences and outcomes.

1. Materials and methods

In order to gain a better understanding of the underlying processes that may influence participants' behaviour, the interpretivism paradigm (Brancati, 2018), enabling researchers to understand both the context and the cause of differences, has been applied.

The aim of the paper is to extract the accumulated experience of teachers working with digital platforms and applying learning analytics based on artificial intelligence. This article presents a segment of the study aimed at elucidating the experiences of science and mathematics teachers in using learning analytics in the teaching and learning process. To investigate the purposes and methods by which general education schoolteachers in science (physics, chemistry and biology) and mathematics utilise digital teaching/learning platforms integrating learning analytics tools in their subject lessons, a qualitative research methodology was employed. Qualitative methodology was chosen for its ability to provide a holistic, in-depth understanding of participants' experience in real-world contexts, and to access the subjective meanings attributed to these experiences (Denzin, 2018). The research adopted a constructivist-interpretive approach, wherein participants construct meanings through interaction with their context, allowing the researcher to uncover the subjective interpretations of their experience (Merriam, Tisdell, 2016). Consistent with other qualitative studies (John, Creswell, Poth, 2018), focus group interviews served as the data collection method. This method was selected to comprehend and elucidate the meanings, beliefs and experiences influencing the feelings, attitudes and behaviours of individuals (Wilkinson, 2004; Nyumba et al., 2018).

Qualitative research, a valuable approach for exploring various social phenomena using non-numerical data and open-ended, evolving questions (Maxwell, Reybold, 2015; Chai et al., 2021), was conducted.

Research questions: What are the perceptions, utilisation practices and experiences of mathematics and science teachers in Lithuanian schools of general education regarding learning analytics tools in their classrooms? How do these teachers utilise learning analytics data to inform their instructional decisions in teaching mathematics, physics, chemistry and biology? Additionally, what challenges, benefits and effective strategies do teachers identify in integrating learning analytics tools into classroom instruction?

Research methods. During the implementation of the project 'Artificial intelligence in schools: scenarios for the development of learning analytics in the modernisation of general education in Lithuania' (No S-DNR-20-4), focus group interviews were conducted with different groups of teachers. Among the teachers who participated in the project (a total of 43 teachers), Eduten Playground, Matific and LearnLab digital learning platforms were predominantly used in their classes.

Research tool. Focus group discussions were implemented as a valuable research tool for exploring complex topics, such as teachers' experiences with learning analytics in science and mathematics education. By facilitating group discussions, researchers can uncover diverse perspectives and generate nuanced insights that contribute to a deeper understanding of the research phenomenon. Moreover, choosing a focus group for this particular group of teachers allows for an in-depth exploration of their experiences, challenges and best practices, providing valuable data that can help improve mathematics and science teaching in the general education sector. The teachers' shared expertise creates a conducive environment for generating in-depth and

relevant insights into their teaching practices. The open-question questionnaires for the focus group discussions were developed by researchers on the basis of theoretical analysis.

Research sample. The 43 teachers who participated in the project were divided into several groups based on their educational sector (primary, basic, gymnasium) and the subjects they teach. Consequently, teachers who teach mathematics and science in general education schools formed one group, consisting of 12 members. Moreover, a criterion sample was created for the focus group in this research: teachers were selected according to two main criteria, work experience with digital platforms (at least one year), and work experience in the application of learning analytics (at least one year), i.e. all the teachers who participated in the study had work experience with digital platforms and applying learning analytics based on artificial intelligence.

Coding. A total of 12 teachers took part in the study, comprising four science education teachers and eight mathematics teachers, all with over five years of teaching experience and previous work with digital teaching and learning platforms integrating artificial intelligence and learning analytics. In the research results section, the changed names of the informants (e.g. M-Mathematics, M1-M8, S-Science, S1-S4) are indicated alongside the interview quotes.

Data analysis. An interpretative analysis was employed in this study focusing on understanding the deeper meanings and insights embedded in the qualitative data. This approach goes beyond merely identifying themes or categories; it seeks to uncover the underlying patterns, connections and contexts that informants conveyed through their responses. By applying interpretative analysis, the researcher aimed to gain a more nuanced understanding of the participants' experiences, perspectives, and the complexities inherent in their responses, providing a richer and more comprehensive view of the data. This method is particularly effective in capturing the subjective realities and diverse viewpoints that emerge from open-ended qualitative research (John, Creswell, Poth, 2018).

Research ethics. Throughout the study, careful measures were taken to avoid causing any harm to the teachers involved. The two main ethical priorities were securing informed consent from participants and maintaining their confidentiality.

2. Results

When analysing the research data, four discussion topics of the focus group of science education and mathematics teachers were distinguished: the purpose of using digital platforms integrating learning analytics; the benefits of learning analytics in learning science and mathematics; learning analytics capabilities in integrating science education and mathematics; and technological skills of science and mathematics teachers to leverage learning analytics.

4.1. The purpose of using digital platforms with learning analytics tools in science and mathematics lessons in Lithuanian general education schools

By utilising learning analytics in mathematics and science education classes, teachers aim primarily to assess students' learning achievements individually or as a whole class. For instance, one teacher stated: 'I use learning analytics to find out where students have gaps' (M3), emphasising the importance of identifying areas where students may be struggling. Another teacher expressed: 'It is very important for me to know what and how much the students have understood' (M6), highlighting the need for insights into student comprehension. Additionally, a teacher noted, '[...] the platform made it possible to reveal the potential of every student, with clear and detailed analytics enabling us to see everyone's successes and obstacles' (M1), underlining the value of personalised insights into student progress. Furthermore, another teacher mentioned: '[...] understanding what the students do well, what they struggle with, and what should be emphasised in future lessons' (S4), emphasising the importance of understanding students' strengths and weaknesses. To sum up, according to the informants, these insights into learning gaps, students' lack of knowledge, and their ability to apply knowledge, become focal points for teachers to make informed decisions regarding classroom ins-

truction and the selection and preparation of learning materials. Digital platforms with integrated learning analytics streamline many routine teacher tasks, allowing mathematics and science teachers to devote more time to reviewing learning content and preparing educational tasks. This shift in focus enables educators to deliver more targeted instruction, address individual student needs more effectively, and optimise learning outcomes in mathematics and science education.

When analysing the research data, it became evident that in the schools participating in the study, the use of learning analytics tools is a top priority in science and mathematics lessons. Teachers aim to identify gaps in students' learning, assess which subject topics students understand, and at what level, and determine any issues in applying knowledge and identify lacking skills essential for learning (in mathematics, physics, chemistry and biology).

Equally important for teachers is the ability to differentiate and individualise teaching and learning in classes. They aim to tailor tasks to meet the needs of diverse learners and make timely decisions about addressing individual learning problems. As one teacher expressed, 'These data (generated by learning analytics in digital platforms) allow us to get to know students better not only in terms of their knowledge but also in terms of their mathematical abilities' (M5). This knowledge enables the proper differentiation and individualisation of teaching in the classroom, as was emphasised by another teacher (S3). Teachers also recognise the importance of fostering general abilities, such as cooperation, self-directed learning and critical thinking. These skills are essential for students' overall academic success and lifelong learning. Furthermore, participants in the discussion highlighted the benefits of learning analytics in selecting learning tasks for students and the flexibility offered by digital platforms. These platforms allow students to work at their own pace and provide personalised learning experiences tailored to their individual needs and preferences.

In summary, according to study participants, learning analytics tools play a crucial role in supporting teachers' efforts to understand students' learning needs, tailor instructions to meet those needs, and foster the development of essential skills for academic success and beyond. The integration of learning analytics into science and mathematics education holds great promise for enhancing teaching and learning outcomes, promoting student engagement, and facilitating personalised learning experiences.

4.2. The benefits of learning analytics in learning science and mathematics

Mathematics and science teachers underscored the advantages of digital teaching and learning platforms that are based on artificial intelligence and integrate learning analytics tools for students or groups of students. In both science and mathematics lessons, these digital learning platforms serve not only to personalise and individualise learning content, but also to foster student motivation for active learning beyond the classroom. As one teacher noted, '[...] students willingly solve problems at home' (M2), indicating a high level of student engagement outside regular class hours. Another teacher mentioned: '[...] students even spent several hours after classes preparing assignments and discussing among themselves, which they then presented in class' (M1), illustrating the depth of student involvement and collaboration.

Teachers highlighted students' active participation in learning and their motivation to engage with mathematics and natural sciences as crucial factors for achieving positive learning outcomes. By incorporating digital learning platforms into the teaching process, educators aim to create conditions conducive for learning and motivation. According to the informants, learning analytics tools provide tailored learning experiences that cater to individual student needs and preferences. Through personalised learning pathways, interactive activities and immediate feedback mechanisms, students are empowered to take ownership of their learning journey, and are motivated to explore and deepen their understanding of mathematical and scientific concepts.

In order to ensure deep learning among students in mathematics and science classes, it is crucial to provide opportunities for individualised learning paces, as was highlighted by one participant (S4). Additionally, it is important to assist each learner in fully comprehending and delving into new topics, as was emphasised by another participant (M8), and to reinforce newly acquired knowledge and skills, as was noted by yet another participant (M1). Digital teaching and learning platforms that leverage artificial intelligence and learning

analytics tools play a vital role in facilitating deep learning experiences in the classroom. Moreover, comprehensive training is essential for ensuring learning success, encompassing not only intellectual but also emotional engagement with new topics. Whether learning natural sciences (physics, chemistry, biology) or mathematics, individual or group tasks presented on digital learning platforms allow students 'to explore and discover original approaches to solving problems' (S2), and 'to uncover the contexts surrounding the newly studied topic and construct their own understanding' (S3).

To sum up, according to the study participants, by offering personalised learning experiences, digital platforms empower students to take ownership of their learning journey, explore topics in depth, and engage with the material in meaningful ways. These platforms provide a supportive environment for students to develop critical thinking skills, foster creativity, and cultivate a deeper understanding of mathematical and scientific concepts.

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 (a number of them) individually and to the whole class, which must be completed in order to get a reward (winning the game); the tasks are rich in animation elements. These digital platforms, which integrate learning analytics tools, provide opportunities for teachers and students to individualise the tasks of mathematics education, help students experience success in performing tasks that are suitable for him or her, increase students' confidence in their own abilities, and motivate them for further learning.

On digital platforms designed for learning mathematics, considerable emphasis is placed on incorporating game elements into tasks. Teachers have the flexibility to assign tasks of varying complexity, both individually and to the entire class, with the incentive of earning rewards upon completion (winning the game). These tasks are often enriched with animation elements to enhance engagement and interactivity. According to the focus group participants, these digital platforms, which integrate learning analytics tools, offer a wealth of opportunities for both teachers and students to customise mathematics education tasks. They enable teachers to tailor tasks to individual students' needs, allowing each student to experience success by completing tasks that are suitable for them. This personalised approach not only fosters a sense of achievement, but also boosts students' confidence in their own abilities. Furthermore, the gamification elements incorporated into these digital platforms serve to motivate students for further learning. By introducing elements of competition, rewards and instant feedback, students are encouraged to actively engage with the material and strive for continuous improvement.

Overall, in the opinion of the informants, the integration of game elements and learning analytics tools in digital mathematics learning platforms creates a dynamic and interactive learning environment. It empowers both teachers and students to individualise tasks, enhance learning outcomes, and cultivate a positive attitude towards mathematics education.

4.3. Learning analytics possibilities in integrating science education and mathematics

By sharing their experiences with learning analytics tools in classes of mathematics and natural sciences (physics, chemistry, biology), teachers identified new opportunities for integrated learning. They highlighted the potential of learning analytics and collaboration by preparing joint lessons or integrating tools from the same digital platform into separate educational subjects to achieve synergy in teaching and learning. A clear trend has emerged where teachers from different subjects, such as mathematics and natural sciences, use the same digital learning analytics tools to analyse and interpret student learning data together with their colleagues. As one teacher expressed: 'Together we see data provided about the same students, their diligence, responsibility' (S1). Another teacher mentioned: 'We reviewed student learning data together and discussed how we could enhance learning in our lessons' (M7). This collaborative analysis of data allows teachers to identify students' strengths and weaknesses, and tailor instruction accordingly. Teachers noted that analysing data together often leads to new ideas for organising integrated teaching and learning experiences. For example, one teacher stated: 'We decided to use the same digital tools in our lessons so that students could focus more on deepening the topic and learn collaboratively' (S3).

Furthermore, teachers emphasised that the joint analysis of learning analytics data was crucial for initiating, planning and implementing integrated activities. It provided them with insights into emerging teaching and learning issues across different subjects. When teachers analysed the results of integrated lessons and student reflections, they found that decisions made based on learning analytics data were more effective and had a greater impact on students than expected. Students' reflections indicated not only positive emotional engagement, but also improved learning outcomes, as is evidenced by learning analytics data.

In conclusion, according to the study participants, the collaborative use of learning analytics tools in mathematics and natural sciences education enables teachers to make informed decisions, plan effective instruction, and improve learning outcomes through integrated teaching practices. This approach fosters a supportive learning environment where students are actively engaged and achieve greater success across multiple subjects.

4.4. Technological skills of science and mathematics teachers to leverage learning analytics

According to the focus group participants, the successful implementation of learning analytics tools in science and mathematics classrooms (as well as in other subjects) necessitates a certain level of technological proficiency among educators. Therefore, technological skills are required by science and mathematics teachers to leverage learning analytics effectively.

First, according to the informants: 'science and mathematics teachers need to possess proficiency in searching and utilising certain digital platforms that integrate learning analytics functionalities and are suitable for teaching-learning science and mathematics' (M3). 'As there are a lot of applications and online platforms designed to support teaching and learning activities, it is quite difficult for a teacher to make a good choice' (M5, S4). However, teachers pointed that the proficient use of these platforms that integrate learning analytics enables teachers to collect, analyse and interpret data about student learning behaviours and outcomes, facilitating informed decision-making in instructional planning and delivery.

Another important aspect of leveraging learning analytics, according to the informants, is the ability to analyse and interpret data effectively. The focus group participants agreed that science and mathematics teachers should possess basic data analysis skills to make sense of the information generated by learning analytics tools. This includes understanding statistical measures, interpreting graphs and visualisations, and drawing meaningful conclusions from the data. Proficiency in data analysis empowers teachers to identify patterns, trends and areas of improvement in student learning, guiding them in tailoring instructional strategies to address individual student needs.

Besides this, the study participants emphasised the idea that learning analytics tools increasingly leverage artificial intelligence to analyse and predict student learning behaviours. Therefore: 'science and mathematics teachers should have a basic understanding of these technologies' (M1). 'While they may not need to be experts in artificial intelligence, familiarity with the underlying principles and functionalities of these technologies could enable them to grasp how learning analytics tools operate and generate insights' (S3). This knowledge empowers teachers to make informed decisions about the selection and implementation of learning analytics solutions that align with their instructional goals and objectives.

According to the informants, science and mathematics teachers must demonstrate adaptability and a willingness to engage in continuous learning. Technological advancements and updates to learning analytics tools necessitate ongoing professional development to stay abreast of emerging trends and best practice in the field. Moreover, teachers should be open to experimenting with new tools and methodologies, refining their technological skills through hands-on experience and collaboration with peers.

3. Discussion

The study has shown that the primary aim of employing learning analytics in mathematics and science education in Lithuanian general education, as highlighted by the teachers, is to assess student learning achievements and identify areas for improvement. This assessment is crucial for tailoring teaching methods and

materials to address individual learning gaps effectively. The integration of learning analytics tools streamlines this process, enabling teachers to focus more on refining teaching-learning content than on managing the process. Furthermore, the ability to differentiate and individualise teaching based on students' learning profiles is greatly enhanced through the insights provided by learning analytics. This not only facilitates a deeper understanding of students' capabilities, but also fosters a more personalised learning experience. These implications are in line with other research findings; for instance, learning analytics tools allow teachers to form timely and meaningful assessments of ongoing learning activities (Papamitsiou, Economides, 2015). Learning analytics tools increase teachers' understanding of student achievements (Guo et al., 2017), and potential misconceptions (Papamitsiou, Economides, 2015), and help to improve the effectiveness of planned strategies in curricula and teaching-learning (Meyers et al., 2016). Learning analytics can inform teachers about the quality of instructional content and the impact of teacher-proposed activities, and the effectiveness of their assessment process (Jivet et al., 2018).

The study emphasised that the benefits of digital teaching and learning platforms, coupled with learning analytics tools, extend beyond mere assessment. They serve as catalysts for student engagement and motivation, encouraging active participation both inside and outside the classroom. The ability to personalise learning content and pace, facilitated by these platforms, empowers students to take ownership of their learning journey. Additionally, the integration of game elements in mathematics tasks adds an element of fun and challenge, further enhancing student involvement and confidence. Through such platforms, students are not only equipped with the necessary knowledge and skills, but are also nurtured emotionally, ensuring a holistic learning experience. Other research corroborates these benefits of learning experience platforms. Such systems provide a unified environment for the student to study widely across subjects such as languages, mathematics, science and social studies (Howlin et al., 2019). Each learner has a dynamic learning path and learning goals. The learning path is inseparable from the ability to navigate through the learning material and the ability to consult (and possibly change the path) during learning. Advanced learning platforms ensure that the user can always determine 'Where am I?' functions and compare progress towards the intended learning objectives (Southgate et al., 2018). The platforms are designed to reduce the 'technological noise' that sometimes happens in digital learning. This is especially important when a lot of valuable learning time is wasted on solving technology problems (Kulik, Fletcher, 2016).

The major finding of the study is the potential of learning analytics in fostering collaboration and integration across different subjects. By utilising the same digital learning analytics tools, teachers can collaborate to analyse and interpret student data collectively. This collaborative approach opens up new avenues for integrated teaching and learning, where synergies between different disciplines can be leveraged to deepen the understanding and enhance learning outcomes. The joint analysis of learning data facilitates the identification of common strengths and weaknesses among students, paving the way for tailored interventions and collaborative learning activities. The effectiveness of such integrated approaches is evident from the improvements in student engagement and learning outcomes observed by other research, underscoring the transformative impact of learning analytics in interdisciplinary education (Steenbergen-Hu, Cooper, 2014; Admiraal et al., 2018).

The insights from focus group discussions underscored the essential role of technological proficiency among science and mathematics educators in effectively leveraging learning analytics tools in their classrooms. The participants emphasised the need for teachers to possess proficiency in navigating and utilising digital platforms that integrate learning analytics functionalities tailored for science and mathematics instruction. Furthermore, the study highlighted the importance of data analysis skills among teachers to effectively analyse and interpret the insights generated by learning analytics tools. Additionally, participants emphasised the importance for teachers to have a foundational understanding of artificial intelligence technologies underpinning learning analytics tools. Moreover, the study highlighted the necessity for science and mathematics teachers to demonstrate adaptability and a commitment to continuous learning. These results are in line with international research results that underscore the critical role of technological proficiency, data analysis skills, and a commitment to ongoing learning among science and mathematics educators, in harnessing the potential of learning analytics to enhance student learning outcomes and instructional practices (Wong et al., 2023).

4. Limitations of the study

While the analysis of the discussion among mathematics and science education teachers provided valuable insights into the use of digital platforms integrating learning analytics, several limitations should be acknowledged. First, the study had a limited sample size. The study was conducted with a specific group of mathematics and science teachers, which may not represent the broader population of educators. Therefore, the findings may not be fully generalisable in all teaching contexts or other subject areas. Second, a focus group methodology was applied. The primary data collection method was a focus group discussion, which might be influenced by group dynamics, dominant voices, or social desirability bias. This means that some participants may have felt pressured to conform to the opinions of others, potentially affecting the authenticity and diversity of responses. Third, the study was subject-specific, as it focused only on mathematics and science education teachers, limiting the applicability of the findings to other subjects. The integration of learning analytics in different educational fields might reveal different challenges and opportunities. Fourth, the study participants' level of experience and proficiency with digital platforms and learning analytics could have influenced their perspectives and the depth of insights shared. Teachers who are less familiar with technology may not have fully articulated potential benefits or challenges. Fifth, the study captures insights based on a specific time frame, which might not reflect long-term impacts or the sustained effectiveness of integrating learning analytics into teaching practices. Longitudinal research would be necessary to understand how learning analytics influence teaching and learning over time. Moreover, the study focuses primarily on teacher perspectives, without incorporating feedback or insights from other interested parties, such as students. Understanding student experiences with learning analytics would provide a more comprehensive view of its impact on the learning process.

Conclusions

The analysis of the discussion among mathematics and science education teachers reveals significant insights into the utilisation of digital platforms integrating learning analytics in educational settings.

The results of the focus group discussion of science education and mathematics teachers on the purpose of using digital teaching and learning platforms integrating learning analytics into lessons revealed that the priority purpose of learning analytics lessons is to identify and record students' learning achievements, knowledge and skill gaps in a timely manner.

The analysis of student learning presented on digital platforms based on artificial intelligence and integrating learning analytics allows teachers to make the most appropriate decisions regarding the organisation of teaching in lessons: to differentiate and individualise teaching, and to consistently develop students' general competencies. Learning analytics provide educators with insights into student progress and performance, enabling early intervention and content quality improvement.

The results of the discussions highlighted the benefits to students of learning analytics tools: learning analytics tools allow students to see personal progress, receive tasks assigned to them individually, experience collaborative learning, engage (intellectually and emotionally) in learning activities, and 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 organisation decisions by consensus. Participants in the discussion also noticed the synergistic possibilities of learning analytics in organising integrated mathematics and science education. The results underscored the critical role of technological proficiency, data analysis skills, and a commitment to ongoing learning among science and mathematics educators in harnessing the potential of learning analytics to enhance student learning outcomes and instructional practices.

The research results revealed that the development of learning analytics application models and the analysis of their effectiveness are important directions for further research.

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MOKYMOSI ANALITIKA MATEMATIKOS IR GAMTOS MOKSLŲ PAMOKOSE: LIETUVOS ATVEJO ANALIZĖ

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Santrauka

Straipsnio tikslas – ištirti ir išanalizuoti sukauptą mokytojų patirtį dirbant su skaitmeninėmis platformomis bei taikant dirbtiniu intelektu pagrįstą mokymosi analitiką matematikos ir gamtos mokslų pamokose. Tiriant mokytojų perspektyvas ir patirtį, straipsnyje pristatomu tyrimu siekiama atskleisti vertingų įžvalgų apie iššūkius, naudą ir veiksmingas mokymosi analizės priemonių integravimo į mokymą klasėje strategijas. Šio tyrimo išvados gali padėti kurti įrodymais pagrįstas strategijas ir politiką, padedančią veiksmingai integruoti mokymosi analizės priemones į švietimo praktiką, gerinant mokinių mokymosi patirtį ir rezultatus.

Mokslinės literatūros analizė atskleidė, kad pastaruoju metu vyraujanti švietimo sektoriaus skaitmenizacijos tendencija paskatino sparčią švietimo technologijų plėtrą, kartu ir įvairių su švietimo procesu susijusių duomenų kiekio augimą bei poreikį tuos duomenis analizuoti. Mokymosi procese surinkti duomenys patenka į mokymosi analitikos sritį. Mokymosi analitika susijusi su plačiomis individualizuoto, diferencijuoto ir personalizuoto mokymosi organizavimo galimybėmis. Be to, gamtamokslinio ir matematinio ugdymo individualizavimas ir personalizavimas laikomas vienu iš Lietuvos švietimo prioritetų, siekiant mokyklose ugdyti inovacijų kultūrą. Pripažįstama integruoto ugdymo svarba siekiant tvaraus mokinių kompetencijų tobulinimo: sprendžiamos gamtos mokslų ir matematikos integruoto organizavimo pamokose problemos, ieškoma tinkamiausių didaktinių sprendimų ir pan.

Viena vertus, mokymosi analitikos priemonės, integruotos į skaitmenines priemones ir platformas, leidžia mokytojams išplėsti ir tobulinti mokymą klasėje, pagerinti mokymosi kokybę šalinant mokinių mokymosi skirtumus ir pritaikyti mokymo bei mokymosi patirtį. Kita vertus, mokymosi analitikos priemonių naudojimo mokykloje sėkmė priklauso nuo to, kaip mokytojai ir mokiniai suvokia šių skaitmeninių priemonių naudą ir kaip efektyviai jas integruoja į savo mokymo(si) praktiką. Be to, dirbtiniu intelektu pagrįstų mokymosi analizės priemonių teikiamos galimybės keičia mokymo(si) proceso formas, metodus bei vaidmenis, skatina diferencijavimą, individualizavimą, personalizavimą ir dar daugiau.

Šis straipsnis grindžiamas kokybiniu tyrimu, kuriuo siekta atskleisti mokymosi analitikos taikymo galimybes gamtos mokslų ir matematikos pamokose. Tyrimo imtį sudarė Lietuvos bendrojo lavinimo mokyklų mokytojai. Taikytas kokybinis tyrimo metodas – grupinės diskusijos (angl. *focus group*) metodas. Grupinės diskusijos tikslas buvo atskleisti mokytojų sukauptą patirtį dirbant su skaitmeninėmis platformomis ir taikant dirbtiniu intelektu pagrįstą mokymosi analitiką matematikos bei gamtos mokslų pamokose.

Tyrimo rezultatai atskleidė, kad matematikos ir gamtos mokslų dalykų mokytojai neabejoja skaitmeninių platformų, integruojančių dirbtiniu intelektu pagrįstą mokymosi analitiką, nauda nustatant mokinių (klasės) mokymosi spragas, mokymosi ypatumus, priimant duomenimis pagrįstus sprendimus dėl mokymosi diferencijavimo ir individualizavimo. Tyrimo dalyviai įžvelgė mokymosi analitikos generuojamų duomenų svarbą planuojant ir organizuojant integruotas matematikos bei gamtos mokslų ugdymo pamokas.

PAGRINDINIAI ŽODŽIAI: *mokymosi analitika, gamtos mokslai, matematikos pamokos*.

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