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Pupils' experiences of learning analytics visualizations in supporting self-regulated learning in an elementary school classroom

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Abstract

Research on the utilization of learning analytics in elementary school classrooms has been scarce. As different technologies have changed physical and digital learning environments, technology provides possibilities for novel ways to support and enhance learning. The aim of this study was to investigate the perspectives of elementary school pupils on learning analytics and self-regulated learning during a phenomenon-based learning module in a blended learning environment. A total of 89 pupils participated in the learning module and were observed. Furthermore, 10 pupils were interviewed after completing a learning module. A qualitative content analysis was conducted. The results revealed that, overall, pupils' experience of self-regulated learning and learning analytics was positive and learning analytics was perceived as functional and motivating and to have helped their learning. Pupils also became increasingly self-directed during the study module. However, setting goals, and managing to pursue them, appeared to be quite difficult for many pupils. The findings of this study provide new perspectives for the role of learning analytics as an important additional level of support for pupils' self-regulated learning. Altogether, the results indicate a need for further developing pedagogical approaches to using learning analytics within the context of the elementary level classroom.

Keywords: self-regulated learning, learning analytics, elementary school pupils

Introduction

In recent decades the role of self-regulated learning (SRL) in teaching and learning has grown in importance. According to Murdoch-Eaton and Whittle (2012), learners should acquire skills for lifelong learning and the ability to self-regulate and adapt to changing environments. SRL can be regarded as part of 21st century skills, of which there are several definitions (Voogt & Roblin, 2012). Typically, these skills focus on readiness to use technology, critical and creative thinking, and, most of all, learning skills, i.e., the readiness and ability to learn in order to deal with new and changing situations. These global descriptions of 21st century skills can be seen on a more local level. In Finland, the core curriculum for elementary schools contains so-called transversal competences, which focus, for example, on well-being competence, interaction competence, multiliteracy and creativity, societal competence, ethical and environmental competence, and global and cultural competence (EDUFI, 2014). The aim in the core curriculum is that learning these competences is facilitated across different school subjects. The Finnish National Agency for Education (EDUFI) (2014) also requires schools to design and conduct multidisciplinary modules or phenomenon-based learning modules at least once a year. In the phenomenon-based learning approach, a phenomenon is explored through multiple perspectives or school subjects (e.g., Kangas & Rasi, 2021), often utilizing group work and project-based learning. In this learning process, students' self-regulated learning skills become

necessary. However, SRL should also be considered a target of learning, and the pedagogical approaches used should be designed in such a way that supports the development of students' SRL skills.

Along with self-regulation skills, different technologies play an important role in today's education. The development of educational technology has long traditions (Reiser, 2001) providing various tools and approaches for supporting students' learning. One of the development approaches has been identifying ways of developing technologies that provide students with personalized tasks and support. One of the first phases of this approach was so-called intelligent tutoring systems (ITS), designed to provide students with personalized support and learning activities (Corbett et al., 1997). Since ITSs were introduced, their development has continued rapidly with several overlapping research fields. Currently, learning analytics (LA) appears to be gaining a key position in this field (Valtonen et al., 2022). LA is typically defined as follows: "the measurement, collection, analysis, and reporting of data about learners and their contexts, for the purposes of understanding and optimizing learning and the environments in which it occurs" (LAK, 2011). The methods and technologies designed in the field of LA provide various ways and opportunities for understanding learning processes and developing ways to utilize this understanding for different ways of supporting teaching and learning processes.

Combination of SRL and LA is an interesting but challenging area, particularly from the perspective of elementary level education. The role of SRL is strongly emphasized in today's schools. However, the skills needed for SRL should not be taken for granted and require ways to provide students with support (Dignath, & Büttner, 2018). For this purpose, the personalized support provided by LA is crucial. Based on the LA literature, the integration of LA is often considered challenging at the elementary school level, and research in this area is scarce (Phillips & Ozogul, 2020). The elementary school level context differs from the general LA research context because LA is used in a blended context, as the learning management system (LMS) is used in a pedagogical design in which pupils work in a physical classroom. With recent technological developments, such as one-to-one computing (see, Lei & Zhao, 2008), cloud computing (see González-Martínez et al., 2015) and other related and more personal platforms, the possibilities of LA are now also available to elementary schools. This paper focuses on this theme by exploring how elementary school pupils perceive the use of learning analytics and self-regulated learning.

Self-regulated learning in an elementary school learning environment

Theoretically, self-regulation refers to students' active participation in their learning process metacognitively, motivationally and behaviorally (Zimmerman, 2011), which

induces a student to become a strategic learner (Hadwin & Oshige, 2011). Self-regulated learning (SRL) can be defined as "self-regulated thoughts, feelings, and actions that are planned and cyclically adopted to the attainment of personal goals" (Zimmerman, 2000). The cyclical process includes the forethought phase, performance phase and self-reflection phase. According to Zimmermann (2000, 2002), the forethought phase includes task analysis (goal setting and strategic planning) and self-motivation beliefs (e.g., self-efficacy and intrinsic motivation), whereas the performance phase is divided into self-control (e.g., help seeking) and self-observation. Students may, for example, have task strategies and use self-instruction. The self-reflection phase is further divided into self-judgement and self-reaction (Zimmerman, 2000). Panadero et al.'s (2017) meta-analysis has shown that self-assessment is positively related to self-regulated learning strategies. On the other hand, novices may fail to set specific goals for their learning in order to systematically monitor their own learning (Zimmerman, 2002).

Self-regulated learning is based on the assumption that learners play an important role in monitoring their own learning consciously (Winne & Hadwin, 2008). This highlights the students' metacognitive process for setting their own goals for learning and self-monitoring their own processes, how their learning processes proceed, and how the selected ways of learning work. According to Dignath et al. (2008), it is important to provide students with support for their self-regulated learning processes, which is vital for their learning outcomes, strategy use and motivation. Zimmerman (2002) emphasizes the significance of encouraging students to set goals for their learning and to self-evaluate their learning success. For this purpose, focus should be directed at materials that raise their awareness (e.g., Nussbaumer et al., 2015). Furthermore, students should be encouraged to focus on time management, i.e., they should be capable of organizing their work and managing their use of time effectively (Zimmerman, 2002). According to Nussbaumer et al. (2015), in order to support reflection on learning processes, peers can be seen as an important part of the learning situation, which leads to communication and sharing of learning experiences.

Students with well-developed self-regulation strategies appear to use various approaches for supporting their learning, for example, seeking assistance, minimizing distractions and using the available resources (Alvi & Gillies, 2021). Furthermore, students may utilize co-regulation, which is seen as a dynamic process in which learning is regulated with others (e.g., Hadwin et al., 2011), for example, between a student and a more capable other, i.e. a peer or a teacher (Hadwin & Oshige, 2011). However, some students appear to use their own cognitive strategies, such as re-visiting or searching for information and metacognitive strategies (e.g., planning and self-evaluation) (Alvi & Gillies, 2021). Nevertheless, according to Dignath et al. (2008), self-regulated learning training programs appear to be effective, even at elementary school level.

Learning environments with learning analytics

Learning environments can be defined in different ways. Carvalho and Goodyear (2014) show that learning environments contain physical elements, such as tools and spaces; epistemic elements, such as tasks; and social elements, such as roles and division of work. Manninen et al. (2007) added the technological dimension, including digital spaces as part of the learning environments, i.e., platforms and applications that are mediated by ICT devices. It should be noted that none of these elements alone generate learning, and learning activities always emerge in actual ongoing practices (Carvalho et al., 2020). Nevertheless, learning environments play an important role in teachers' pedagogical choices and students' learning activities. Tools afforded by the learning environment are used to generate activities, yet activities emerge when tools and resources are available (Hinton et al., 2014).

Boekaerts (1999) suggested that there is a two-way relationship between self-regulated learning and learning environments, meaning that learning environments may enhance the acquisition of self-regulatory skills, whereas self-regulatory skills are relevant facilitators of learning and of using the resources available in learning environments. In this sense, the digital space with learning analytics provides interesting opportunities for understanding learning processes, making them more visible to students and teachers (Siemens, 2013). In order to take advantage of LA, learning environments need to contain technologies that allow data to be collected on the students' different learning activities. According to Romero et al. (2019), the collected data can be used for understanding the interaction between different actors, navigation behavior, use of different learning activities and materials, etc. Furthermore, this data can be used for various purposes such as visualizing learning processes, identifying students with difficulties, students at risk of dropping out, etc. (Romero et al., 2019). Within the context of elementary education and SRL, LA can provide valuable help, particularly for students' metacognitive thinking, by providing different recommendations for students based on their learning activities and making the learning process more visible.

Overall, LA provides effective ways of supporting pedagogical practices that emphasize students' self-regulation and metacognitive thinking (Ifenthaler & Schumacher, 2016). Viberg et al. (2020) argue that LA research has started to understand the kind of research and development that is needed in the field of SRL. Learning analytics uses learner-generated data to provide students with more personalized support and feedback (Ifenthaler & Widanapathirana, 2014; Schumacher & Ifenthaler, 2018). Learning environments that use LA allow learners to develop their skills to manage their own learning process (McLoughling & Lee, 2010). According to Schumacher and Ifenthaler (2018), students prefer LA systems that help them analyze and plan their learning in advance, monitor their progress towards achieving their learning goals, and provide them

with opportunities to self-assess and receive just-in-time feedback. The challenge is that research and development for LA is typically targeted at higher education instead of lower education (Phillips & Ozogul, 2020). Nevertheless, based on developments in the technologies used in elementary school level learning environments (Freeman et al., 2017), the opportunities for LA are now also better suited to elementary education. With more personal technologies and learning environments being actively used as part of the learning process, it is possible to collect the data needed to make the learning process more visible for teachers and students.

Aim of the study

The aim of the study was to investigate the perspectives of 5th–6th grade pupils (age 11–13) on learning analytics and self-regulated learning during a phenomenon-based learning module in a learning environment in which the pupils studied online learning materials provided to them via a LMS, while also working in the same physical space. The learning module was designed with principles of self-regulated learning.

Accordingly, the following research questions were addressed:

1. What classroom activities emerged in a blended learning environment (physical, digital, social) using a LMS with visualized learning analytics?
2. What were the pupils' perceptions of their experiences of a learning environment that utilized LA and supported self-regulated learning?

Methods

Research context and participants

The research was part of a project studying the use of LA for supporting pupils' self-regulated learning. In this study, we use the term pupil (younger children in the classroom context) when referring to the target group, however, in the context of the theoretical background we use the term student to refer learners in general. This study targeted an elementary school phenomenon-based study module on the subject of outer space (hereafter 'Space'). The study took place at a teacher training school in which technology is actively used. The learning environment was a large, flexible classroom in which pupils from grades five and six studied at their own pace using personal tablet computers. The classroom was a standard classroom at the teacher training school in which the case-study was conducted, and was designed to be flexible and adaptable and to support interaction. The study module comprised ready-made learning materials divided into five themes, two hours per theme (Tables 1 and 2).

Table 1

Structure of the Space study module

Page	Function
Home	Front page including the structure of the module
Theme 1: **The structure of the Earth** **Theme 2:** **The Earth rotates, and the Moon orbits the Earth** **Theme 3:** **The Earth orbits the Sun** **Theme 4:** **Universe** **Theme 5:** **The Earth's gravity**	Each theme included the following "chapters": Goal setting: "Write down your goals for this lesson? What are you interested in finding out?" Content: including various amounts of theory (text, pictures); video-material; tasks, e.g., quizzes and short writing tasks; learning reflection tasks; instructions Reflection: "How did you achieve your goals? What was easy? What was difficult" Some themes also included assignments: Theme 3 group assignment: "demonstrate how the Earth, Moon and Sun orbit each other" Theme 4 drawing assignment: "draw our Solar System" Theme 5 final assignment
Own Progress	Page for following own progress
Questionnaires	Reflective questionnaires to facilitate reflection on own learning

Table 2

Frequencies of chapters and their contents per lesson theme

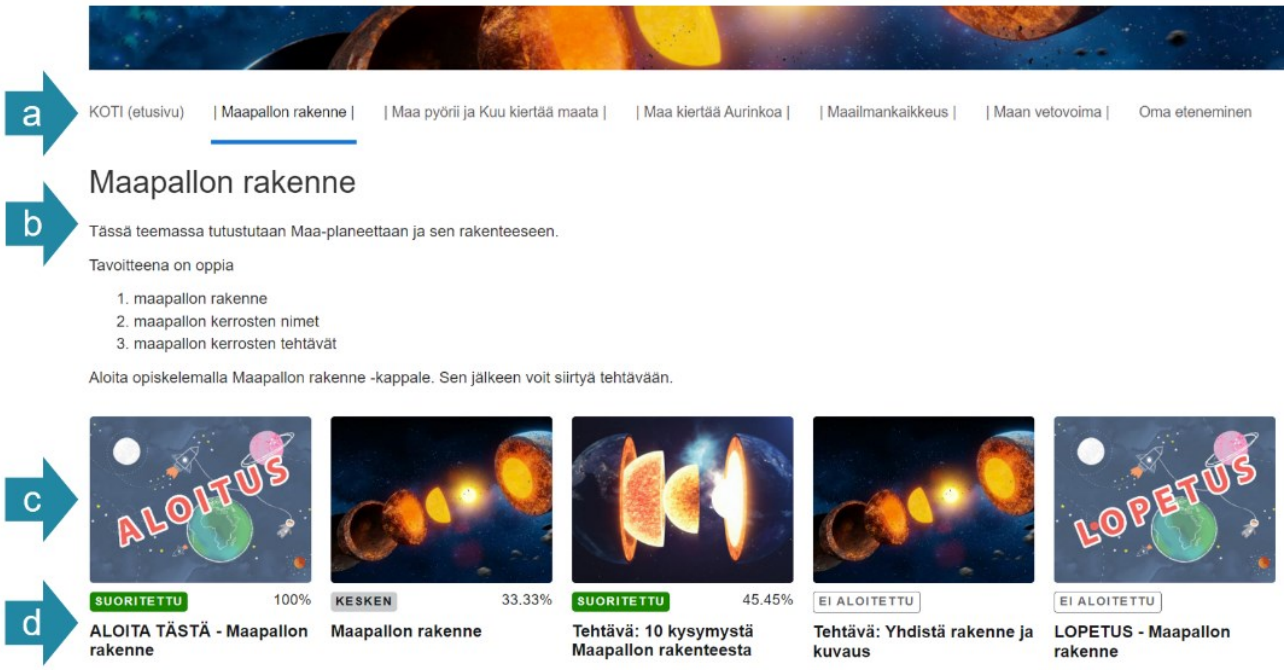
	Chapters			Distribution of chapter page types per theme					
	Goal setting	Contents	Reflec-tion	Theory	Video	Tasks	Instruction & summary	Reflection tasks	Total pages
Theme 1	1	3	1	2	1	16	10	4	33
Theme 2	1	6	1	14	4	12	12	7	49
Theme 3	1	3	1	3	2	19	12	4	40
Theme 4	1	5	1	11	-	22	13	5	51
Theme 5	1	6	1	12	4	22	12	5	53

During the lessons pupils were working in a physical learning environment using their personal tablet computers and a learning management system (LMS) designed for this case study. While working with the topics, pupils were able to talk with and ask advice

from their peers and from teachers. The LMS was designed in accordance with the principles and key phases of the self-regulated learning process (see Zimmerman, 2002, 2000; Panadero, 2017). Learning materials instructed the pupils to actively set goals for their learning at the start of each lesson and monitor their own progress. Furthermore, pupils evaluated the extent to which they were achieving the set goals and reflected on their own learning after the lesson and throughout the entire phenomenon study. The learning module included questionnaires designed to support pupils' active reflection on their own learning from various perspectives. The LMS allowed the teachers to provide the pupils with various kinds of learning materials. Pupils had easy access to them and opportunities to carry out tasks, navigate through activities, read materials, etc. (Figure 1)

Figure 1

Preview of Theme 1 in the LMS, including (a) site navigation, (b) objectives, (c) chapters, and (d) completion statuses and percentages.



Along with assignments and materials, the LMS contained elements of LA. The LMS was designed to collect all the behavioral data from the pupils' learning activities (see Park & Jo, 2015). The aim was that this data would be used for providing pupils with information about their learning process and completed assignments during the Space study module. For this purpose, pupils were provided with an "Own Progress" page (Figure 2), containing information such as the completion percentage and completion status of assignments. In addition, pupils could monitor their progress on theme pages (Figure 1) and within individual chapters (Figure 3). From the pedagogical perspective, the aim was to offer teachers ways to follow the progress of individual pupils using visualizations and to identify pupils with challenges in their learning processes. Altogether, the combination of

classroom learning activities and personal tablet computers with LMS and LA was aimed to provide pupils and teachers with information about the processes of learning. Instead of mere performance measuring, the aim was to make learning processes visible in order to design a pedagogically sound classroom learning environment for the elementary level with benefits from LA.

Figure 2

Example pupil's Own Progress page, including: (a) themes of the learning module, (b & c) completion status (uncompleted, completed, not started) and completion percentage of each theme, and (d) list of completed and uncompleted chapters and assignments per theme.

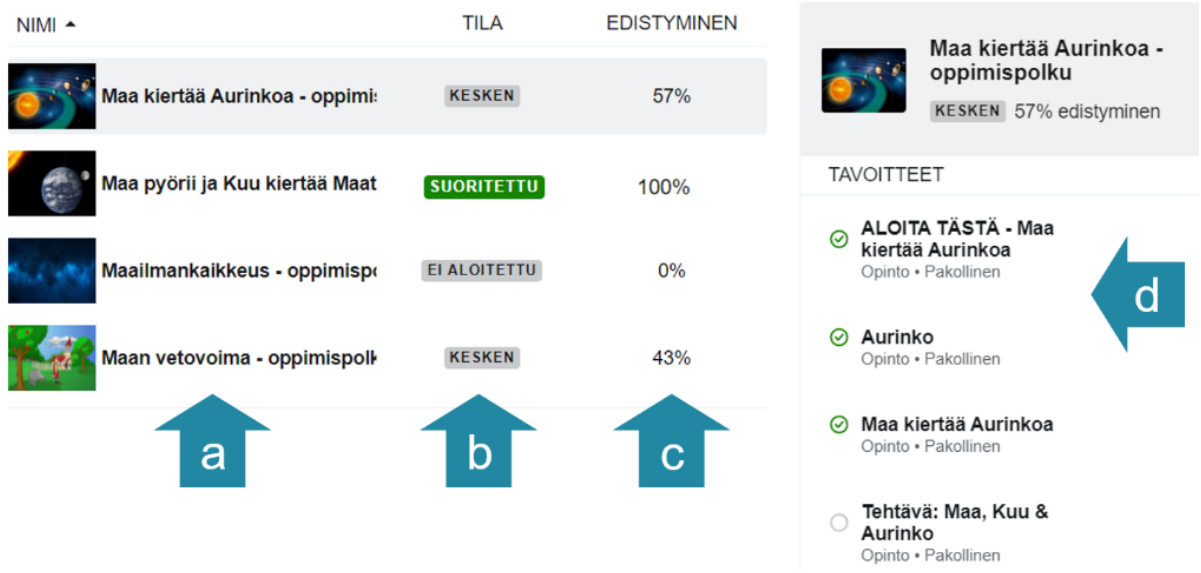


Figure 3

Preview of a task page in a content chapter, including: (a) progress marks indicating completed pages of a chapter and (b) feedback on the task.

A total of 89 fifth and sixth grade pupils (age 11–13) in a Finnish elementary school participated in the study. The sample sufficiently represented the entire pupil population of a particular school in terms of gender. The pupils and their parents/guardians had been sent a briefing and a video about the nature of the study and gave their informed consent to participate in the various stages of the study. Furthermore, the pupils had the opportunity to withdraw from the study at any time if they wanted to. The Committee for Research Ethics granted approval for the design of the study.

Data collection and analysis

The data were collected using classroom observations and pupil interviews during spring 2021. The observation and interview framework were created collaboratively by the researchers. The observations (N=89) were carried out over ten lessons, i.e., classroom activities were observed during classroom learning in order to outline the pedagogical design of the blended learning environment, and the characteristics of the self-regulated learning using LA (e.g., see Griffee, 2005; Perry et al., 2002). Two researchers observed each lesson and wrote down what happened chronologically during the lesson. One of the researchers paid special attention to the activities of the pupils, and the other to the teachers.

Semi-structured interviews were conducted with the pupils on a voluntary basis (N=10) after they had completed the phenomenon-based learning module. The pupils were

interviewed face-to-face individually. They were asked to bring their own tablet computer, which enabled them to view material supporting the interview. The semi-structured interviews explored the pupils' views and experiences of learning analytics and self-regulated learning. More specifically, the questions included themes on how the pupils felt about learning during the module and how a learning environment using learning analytics supported the pupils' self-regulated learning. The interviews lasted for an average of 30–40 minutes. They were audio-recorded and transcribed verbatim into text files.

The analysis was conducted using qualitative, theory-led content analysis (e.g., MacFarlane & O'Reilly-de Brún, 2011). The theoretical starting point for the self-regulated learning was based on Zimmerman`s theory of self-regulated learning (2000). This theory also served as a basis for data collection and analysis. The analysis of the both data started by reading through all the material in order to gain an overall understanding. First, the observation framework for the study was based on three dimensions of classroom activities; 1) climate, 2) management, and 3) instruction (e.g., Stipek & Byler, 2004; Lerkkanen et al., 2016). The observation data were used to answer the first research question. Particular attention was paid to what kinds of classroom activities emerged in a blended learning environment to get an overall picture of what happened in the lessons in relation to classroom activities and the use of the LMS platform. After that, observation perspectives guided the analysis of the interview data, i.e., analysis was conducted aligned with deductive approach (Elo & Kyngäs, 2008). The data were categorized as 1) self-regulated learning and self-regulation, 2) guidance and support, and 3) learning environment and learning analytics.

Results

What classroom activities emerged in a blended learning environment (physical, digital, social) using a LMS with visualized learning analytics?

This first results section is based on observations conducted during the lessons. Based on the observations, the pupils mainly focused on studying, and were accustomed to working independently, as well as using their personal tablet computers. Based on the observations, the climate during all the lessons appeared to be positive and safe, providing optimal conditions for the pupils' self-regulated learning.

The pupils mainly worked on their own in the classrooms, using their tablet computers, reading and studying through the materials and tasks in the LMS. The pupils' opportunities to influence their own learning was considered in the learning processes. The pupils were able to choose the order of the tasks to be completed during the lesson. Also, the large, flexible learning environment allowed the pupils to choose their own place to work in the physical space. The structure of the ten lessons followed a fairly similar pattern

in each lesson. The teacher started the lesson by introducing the theme and then instructed the pupils to work independently. Based on the observations, it seemed that the pupils were quite capable of studying at their own pace using the materials provided for them. As the module progressed, the work became more fluent, the pupils collected their tablets on their own and mainly knew what tasks they needed to continue working on.

The results showed variation among the pupils regarding how well they proceeded with their study process and how much support they appeared to need. Most of the pupils were able to work on their own. They took responsibility for their work and they appeared to be comfortable with this. However, at times, the focus of some of the pupils appeared to shift away from the tasks and they became somewhat inactive. During the process, there were a number of pupils who did not understand the instructions and needed more individualized advice. These pupils appeared to need support, particularly with practical issues, how to work on different tasks and assignments, as well as how to use certain technologies. Together with these issues, instructions and help were typically needed in the transition phases from one theme or task to another. The pupils needed support in progressing from one area to another, indicating challenges in their metacognitive readiness.

Based on the observations, four levels of support and guidance were identified: 1) written instructions and tasks provided by the LMS platform, 2) teachers' spoken guidance and feedback, 3) pupils' peer support and co-regulation and 4) learning analytics visualizations provided by the platform. First, the instructions and tasks provided in the LMS offered the pupils guidance on how to study and proceed, even though they had opportunities to choose their own progress strategy. Second, the teachers provided constructive feedback about the pupils' behavior and they also advised the pupils to check their tasks. The pupils received encouraging spoken feedback from their teachers both individually and on a group level several times during the Space study module. It was also noted how teachers offered assurances to pupils regarding their ability to perform the task at hand. Some pupils received less attention, and the teachers only advised pupils when necessary. It was clear that the teachers primarily supported pupils who appeared to have challenges with learning or self-regulation. Even though the study module was designed for individual studying, a third level of support emerged, which highlighted the importance of co-regulation and peer-support. The pupils advised each other, and even instructed other pupils to listen or change their behavior on some occasions. When a pupil went to collect a set of headphones or some paper, other pupils appeared to follow that model and behave in a similar way. Thus, the learning platform clearly appeared to guide the pupils and the importance of peer support still appeared to be evident. However, also a fourth level of support, learning analytics as part of the LMS, seemed to guide the pupils' independent work. The 'Own Progress' page in the LMS enabled the pupils to monitor their own learning process, visualize the completed themes, and consider the next stages of the process. Regarding the ways of learning and working within the modules, the pupils

became accustomed to studying and working on their own and the need for support from teachers and other students during the module decreased.

What were the pupils' perceptions of their experiences of the learning environment that utilized LA and supported self-regulated learning?

The interviews showed that pupils had difficulties in setting goals for their learning. In particular, the interviews with 5th graders highlighted the challenge of setting goals, whereas the 6th graders appeared to be somewhat more accustomed to setting goals. Some pupils even expressed their frustration with the constant setting of personal goals. One pupil stated how they knew that goals were important but still found them frustrating. Another pupil stated that they were unable to set goals at all.

Most pupils did not have high expectations or goals for this module of phenomenon-based study. The pupils stated that they wanted to learn as much as possible, but many of them had difficulties setting clear contextualized goals for their own learning. However, according to the interviews, the pupils appeared to be able to set goals for their learning if the teachers specifically instructed them to do so. Also, most pupils were able to understand what they were supposed to learn during the phenomenon-based learning module. However, some pupils only listed the general lesson themes of the module as goals. This implies that the pupils only developed self-regulatory skills, such as setting goals for their own learning.

Almost all the pupils expressed their satisfaction and sense of success during the module, particularly at the end. Most of them found the tasks quite easy, but some tasks, such as content related to Newton's law, they found more difficult. Most of the pupils talked about themselves in a neutral and positive manner. Some of the pupils also skillfully reflected on their own metacognition, mentioning how they reflected on their own thinking about learning and setting goals. For these pupils, self-regulated learning appeared to be a positive experience, according to the interviews. Contextual clarifications added by the authors are marked by brackets.

> I: "So … did you set any goals for learning?
> P: Well, I [was thinking that I] have to practice this thing, that's how it goes, but I still have to train more so that it stays in my memory."

Some pupils talked about their self-confidence, for example, one of the pupils appeared very capable of identifying the factors that affected her own self-confidence and self-efficacy:

> I: "In what things did you think you were succeeding?

> P: A little bit in everything!"
> P: "I feel like I did quite well in those tasks because everything [all the task points] went almost to one hundred percent and only a few [task points] went to ninety, and right away for the first time.
> I: So you checked how much you got right and..?
> P: Yeah, I checked it from here [i.e. under the lesson page]."

Thus, based on the interviews, it can be seen that at least some of the pupils felt that the learning analytics supported their learning processes and being guided independently. One pupil described how they tried to do a task over and over again so that the completion bar no longer looked like an incomplete entry. Furthermore, the pieces of text included in the LMS were also perceived by the pupils as functional, as they were able to return to them to re-examine the issues. A couple of pupils specifically pointed out how they returned to these texts if they did not understand the issue in question. This implies that the digital learning environment and learning analytics have good potential to support pupils' self-regulated learning.

> "... when I did those tasks, I never asked for help. I understood everything that I had to do there [on the LMS], and I was able to answer them [tasks and quizzes]. And if I wasn't able to do them [compete the tasks], I tried over and over again..."

During the performance phase, reflection on task strategies often took place on a subconscious level. Almost all the pupils stated that they had completed tasks for each lesson in the suggested order, even if they had an opportunity to choose. Most pupils said they had focused on the assigned tasks and not on the other activities. Many pupils wanted to try to understand the issue for themselves for as long as possible, rather than seek help from peers or teachers.

> "I tried to figure them [tasks] out myself, but in a few tasks, for example, I asked [advice from] a few group members. From the teacher, I didn't ask [about tasks] much. As I [usually] thought that I would get it [a task] done, and if I didn't get it [a task] done, I would ask a friend. However, if I hadn't been able to work it [a task] out, I would have probably asked the teacher."

The interviews showed that some pupils had problems reflecting on their own learning. However, most pupils were able to reflect on their own learning, particularly when they achieved something. Some pupils were even able to assess what might have disrupted their learning and what supported their learning.

The pupils reported how important guidance and support were for their studying and learning and, furthermore, that they had helped their peers or asked for help if needed. The pupils perceived that they were able to control their feelings and behavior with the help of other pupils. Conversations with peers were perceived as helpful and exhilarating.

This implies that even if the study module was constructed for individual learning via a LMS, pupils also saw the significance of co-regulation for their learning.

Most of the interviewees found the digital platform inspiring and supportive of learning. Also, the digital learning environment was perceived as a different kind of experience compared to previous learning experiences. The importance of texts, images and videos was highlighted. The pupils reported, for example, that they had returned to the texts if they did not remember something. Also, they were able to read instructions from the platform at any point. However, some pupils could not assess whether the platform had helped, but still felt that the Space module lessons were quite enjoyable.

> "I'll say straight away that it was really great --- and it was great to learn there."
> "This was easy. The tasks were easy to access and there weren't many technical problems."

According to the results, the pupils appeared to take advantage, at least to a certain extent, of the opportunities provided by learning analytics to track their own learning and task performance. For example, one pupil stated that it was exciting that they could get to see so many things through the learning analytics visualizations. Thus, in this context, learning analytics, at its best, motivated the pupils and guided them to independently follow their own progress and identify successes and challenges in their learning.

The interviews showed that the pupils took responsibility for their own learning. However, they did not appear to regulate their own learning as much as was expected by following the 'Own Progress' page, which included all LA visualizations. Less than half of the pupils interviewed reported using this page. However, the completion rate (%) of the tasks, which could be seen from the learning material pages, motivated some pupils and guided them to learn and to try again.

> "But I had to do some of the tasks again. If one of the tasks went wrong, I got annoyed that I didn't get a hundred percent and then I had to do it again."

Discussion

This study aimed to explore the learning activities in a face-to-face classroom learning environment, equipped with a LMS containing LA visualizations. The findings of the study bring novel perspectives for using learning analytics within elementary level classroom teaching, targeting pupils' self-regulated learning. The results show that, in terms of the forethought phase of self-regulated learning (see Zimmerman, 2000), setting learning goals and following them is still a challenging area for some pupils towards the end of elementary school education, although the utilized LMS was also built to support this process. The findings suggest that pupils do not generally set goals for their learning. It is

therefore important to consciously guide pupils to set goals and to investigate more how digital learning environments could support pupils with this issue. Support in the classroom context appeared to be needed, particularly for the transition phases, e.g., from one task to another. These factors can be regarded as key issues when considering the regulation of learning activities for achieving personal learning goals. Zimmerman (2002) highlights the significance of encouraging students to set goals for their learning and to self-evaluate their learning success. We assume that the pedagogical approaches of using LMS with LA visualizations, as used in this study, can function as facilitating processes, so that conscious and continuing goalsetting practices become pupils' normal learning activity.

The results show that pupils gained support from various directions, from the structure built into the LMS as well as from teachers, peers and the learning analytics. However, the results also revealed a decrease in the level of pupils' help-seeking activities from teachers and peers during the performance phase of study period and module. The pupils advised each other, and even instructed other pupils to listen or change their behavior, and some of them appeared to use the behavior of others as a role model. This implies that even though the digital platform was based on individual learning, the importance of seeking help (Zimmerman, 2000) and co-regulative learning also emerged (see Hadwin et al., 2011; Hadwin & Oshige, 2011). Also, according to Zimmerman's (2000) self-reflection phase, pupils' perceptions of reflecting on their own learning were explored. The results suggest that, in general, pupils were able to reflect on their own learning in terms of what they had learned and what had disturbed their learning. However, some pupils found reflective thinking challenging. This may be related to difficulties in setting goals for their own learning, which should be researched further in the future.

According to Phillips and Ozogul (2020), the elementary school level context has played a minor role in learning analytics research. This study provides a new research perspective to meet this shortcoming, with insights into using LA in an elementary level classroom context. Results showed that pupils take advantage of the opportunities provided by learning analytics, such as viewing visualizations of completed themes for tracking and monitoring their own learning process and performance. The results provide us with phenomena for further research and development work, i.e. the possibilities of learning analytics as a fourth element of support in the classroom context. Also, we see this area as a potential and important target area for further LA research. New technologies capable of collecting data from learning processes can provide pupils with support and personalized learning opportunities, including in face-to-face lessons. In order to do this, pedagogical practices in the use of LA need to be further developed. Pedagogical practices need to be designed in such a way that different activities "leave log tracks"; pupils need to be encouraged to "leave log tracks". Thus, the key elements of pedagogy of LA in elementary level classrooms should be further developed. We argue that these kinds of activities can

help pupils to learn about their own learning and support their metacognitive thinking, and that these log tracks can also be used as LA data to provide pupils with personalized support and learning opportunities. The activities presented in this paper are important for achieving this goal, guiding pupils to understand the core ideas of SRL, and providing them with opportunities to familiarize themselves with how to benefit from LA in their own learning.

There are some limitations that should be taken into account. The potential limitations of the transferability of the results should be noted. The study was conducted in a specific school context that provides a technology-enhanced learning environment for all pupils, and the pupils were familiar with using technology in their daily learning activities. Further research is needed to examine pupils' perspectives on the effectiveness of learning analytics in supporting their self-regulated learning processes. The results could be further elaborated using quantitative questionnaire data, as well as in relation to the actual LA log data, through which we could further understand pupils' behavior in a LMS in this kind of classroom setting. Moreover, the complexity of pupils' self-regulated learning and the support of technology in this process should be further studied using learning analytics.

Conclusion

Based on the classroom activities that emerged in the blended learning environment, pupils were quite capable of studying at their own pace using the materials provided for them, and furthermore, the work became more fluent as the module progressed. Also, they took responsibility for their work. Several pupils did not understand the instructions and needed more individualized advice as well as support to move forward in their working. Peer support was also received, for example, in the form of advice. Learning analytics as a part of the LMS guided pupils in working individually.

Pupils' experiences of self-regulated learning and learning analytics were mainly positive. The digital learning environment and learning analytics were perceived as functional and motivating, and some pupils stated that they helped their learning. Pupils also highlighted how the digital learning environment supported their studying, for example, by providing clear instructions, images and videos, thus there generally appeared to be no need to ask the teacher for help.

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References

Alvi, E., & Gillies R. M. (2021). Self-regulated learning (SRL) perspectives and strategies of Australian primary school students: a qualitative exploration at different year levels. *Educational Review, 1–23* https://doi.org/10.1080/00131911.2021.1948390

Boekaerts. M. (1999). Self-regulated learning: where we are today. *International Journal of Educational Research, 31*(6), 445–457 https://doi.org/10.1016/S0883-0355(99)00014-2

Carvalho, L., & Goodyear, P. (Eds.). (2014). The architecture of productive learning networks. New York: Routledge. https://doi.org/10.4324/9780203591093

Carvalho, L., Nicholson, T., Yeoman, P. & Thibaut, P. (2020) Space matters: framing the New Zealand learning landscape. *Learning Environ Res* 23(3), 307–329. https://doi.org/10.1007/s10984-020-09311-4

Dignath, C., Buettner, G., & Langfeldt, H.-P. (2008). How can primary school students learn self-regulated learning strategies most effectively? A meta-analysis on self-regulation training programmes. *Educational Research Review, 3*(2), 101–129. https://doi.org/10.1007/s11409-018-9181-x

Dignath, C., & Büttner, G. (2018). Teachers' direct and indirect promotion of self-regulated learning in primary and secondary school mathematics classes – insights from video-based classroom observations and teacher interviews. *Metacognition and Learning*, *13*(2), 127–157.

Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of advanced nursing, 62*(1), 107-115. https://doi.org/10.1111/j.1365-2648.2007.04569.x

Finnish National Agency for Education (EDUFI). (2014). National core curriculum for basic education. Publications 2016:5. Finnish National Agency for Education.

Freeman, A., Adams Becker, S., Cummins, M., Davis, A., & Hall Giesinger, C. (2017). NMC/CoSN Horizon Report: 2017 K–12 Edition. Austin, Texas: The New Media Consortium.

Gašević, D., Dawson, S., & Siemens, G. (2015). Let's not forget: Learning analytics are about learning. *TechTrends, 59*(1), 64–71. https://doi.org/10.1007/s11528-014-0822-x

Griffee, D. T. (2005). Research tips: Classroom observation data collection, part 1. *Journal of Development Education, 29*(1), 42.

González-Martínez, J. A., Bote-Lorenzo, M. L., Gómez-Sánchez, E., & Cano-Parra, R. (2015). Cloud computing and education: A state-of-the-art survey. *Computers & Education*, *80*, 132–151. https://doi.org/10.1016/j.compedu.2014.08.017

Corbett, A. T., Koedinger, K. R., & Anderson, J. R. (1997). Intelligent tutoring systems. In *Handbook of human-computer interaction* (pp. 849–874). North-Holland. https://doi.org/10.1016/B978-044481862-1.50103-5

Hadwin, A., Järvelä, S., & Miller, M. (2011). Self-regulated, co-regulated and socially shared regulation of learning. In B. J. Zimmerman & D. H. Schunk (Eds.), *Handbook of self-regulation of learning and performance* (pp. 65–84). New York, NY: Routledge.

Hadwin, A., & Oshige, M. (2011). Self-regulation, coregulation, and socially shared regulation: Exploring perspectives of social in self-regulated learning theory. *Teachers College Record*, *113*(2), 240–264. https://doi.org/10.1177/016146811111300204

Hinton, T., Yeoman, P., Carvalho, L., Parisio, M., Day, M., Byrne, S., Bell, A., Donohoe, K., Radford, J., Tregloan, P., Poronnik, P., & Goodyear, P. (2014). Participating in the communication of science: Identifying relationships between laboratory space designs and students' activities. *International Journal of Innovation in Science and Mathematics Education, 22*(5), 30–42.

Ifenthaler, D., & Schumacher, C. (2016). Student perceptions of privacy principles for learning analytics. *Educational Technology Research and Development, 64*(5), 923–938. https://doi.org/10.1007/s11423-016-9477-y

Ifenthaler, D., & Widanapathirana, C. (2014). Development and validation of a learning analytics framework: Two case studies using support vector machines. *Technology, Knowledge and Learning*, *19*(1–2), 221–240. https://doi.org/10.1007/s10758-014-9226-4

LAK (2011). What is learning analytics? Retrieved from https://www.solaresearch.org/about/what-islearning-analytics, 16 April, 2021

Lerkkanen, M.-K., Kiuru, N., Pakarinen, E., Poikkeus, A.-M., Rasku-Puttonen, H., Siekkinen, M., & Nurmi, J.-E. (2016). Child-centered versus teacher-directed teaching practices: Associations with the development of academic skills in the first grade at school. Early Childhood Research Quarterly, 36, 145–156. https://doi.org/10.1016/j.ecresq.2015.12.023

Knight, S., & Buckingham Shum, S. (2017). Theory and Learning Analytics. In Lang, C., Siemens, G., Wise, A., & Gasevic, D. (Eds.) *Handbook of Learning Analytics*. New York, NY, USA: SOLAR, Society for Learning Analytics and Research. https://doi.org/10.18608/hla17.001

Lei, J., & Zhao, Y. (2008). One-to-one computing: What does it bring to schools? *Journal of Educational Computing Research*, *39*(2), 97–122. https://doi.org/10.2190/EC.39.2.a

McLoughlin, C., & Lee, M. J. (2010). Personalised and self regulated learning in the Web 2.0 era: International exemplars of innovative pedagogy using social software. *Australasian Journal of Educational Technology*, *26*(1). https://doi.org/0.14742/ajet.1100

Manninen, J., Koivunen, A., & Passi, S. (2007). Oppimista tukevat ympäristöt: Johdatus oppimisympäristöajatteluun. Opetushallitus.

Murdoch-Eaton, D., & Whittle, S. (2012). Generic skills in medical education: Developing the tools for successful lifelong learning. *Medical Education, 46*(1), 120–128. https://doi.org/10.1111/j.1365-2923.2011.04065.x

Nussbaumer, A., Dahn, I., Kroop, S., Mikroyannidis, A., & Albert, D. (2015). Supporting self-regulated learning. In S. Kroop, A. Mikroyannidis, & M. Wolpers (Eds.), *Responsive Open Learning Environments* (pp. 17–48). Springer, Cham. https://doi.org/10.1007/978-3-319-02399-1_2

Phillips, T., & Ozogul, G. (2020). Learning analytics research in relation to educational technology: Capturing learning analytics contributions with bibliometric analysis. *TechTrends*, *64*, 878–886. https://doi.org/10.1007/s11528-020-00519-y

Panadero, E, Jonsson, A., & Botella, J. (2017). Effects of self-assessment on self-regulated learning and self-efficacy: Four meta-analyses. *Educational Research Review, 22*, 74–98. https://doi.org/10.1016/j.edurev.2017.08.004

Park. Y., & Jo I. H. (2015). Development of learning analytics dashboard to support students learning performance. J*ournal of Universal Computer Science*, *21*(1), 110.

Perry, N. E., VandeKamp, K. O., Mercer, L. K., & Nordby, C. J. (2002). Investigating teacher-student interactions that foster self-regulated learning. *Educational Psychologist, 37*(1), 5–15. https://doi.org/10.1207/S15326985EP3701_2

Kangas, M. & Rasi, P. (2021). Phenomenon-Based learning of multiliteracy in a Finnish upper secondary school, Media Practice and Education, https://doi.org/10.1080/25741136.2021.1977769

Reiser, R. A. (2001). A history of instructional design and technology: Part I: A history of instructional media. *Educational Technology Research and Development*, *49*(1), 53–64. https://doi.org/10.1007/BF02504506

Schumacher, C., & Ifenthaler, D. (2018). Features students really expect from learning analytics. *Computers in Human Behavior, 78,* 397–407. doi: 10.1016/j.chb.2017.06.303 https://doi.org/10.1016/j.chb.2017.06.030

Schunk, D., & Zimmerman, B. (2008). Motivation and self-regulated learning. Theory, research, and applications. New York: Routledge. (vii–ix).

Stipek, D., & Byler, P. (2004). The early childhood classroom observation measure. *Early Childhood Research Quarterly, 19*(3), 375–397 doi: 10.1016/j.ecresq.2004.07.007

Valtonen, T., López-Pernas, S., Saqr, M., Vartiainen, H., Sointu, E. T., & Tedre, M. (2022). The nature and building blocks of educational technology research. *Computers in Human Behavior*, *128*, 107123. https://doi.org/10.1016/j.chb.2021.107123

Voogt, J., & Roblin, N. P. (2012). A comparative analysis of international frameworks for the 21st century competences: Implications for national curriculum policies. *Journal of Curriculum Studies, 44*, 299–321. https://doi.org/10.1080/00220272.2012.668938

Winne P., & Hadwin, A. (2008). The weave of motivation and self-regulated learning. In D. H. Schunk & B. J. Zimmerman (Eds.), Motivation and self-regulated learning. Theory, Research, and Applications (pp. 294–304). New York: Routledge. https://doi.org/10.4135/9781412964012.n19

Zhang. Y. G., & Dang, M. Y. (2020). Understanding essential factors in influencing technology-supported learning: A model toward blended learning success. *Journal of Information Technology Education: Research, 19 https://doi.org/10.28945/4597*

Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P.R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 13–40). Academic Press, San Diego, California

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory into Practice, 41*, 64–79. https://doi.org/10.1207/s15430421tip4102_2

Zimmerman, B. J., & Schunk, D. H. (2011). Self-regulated learning and performance: An introduction and an overview. In B. J. Zimmerman & D. H. Schunk (Eds.), *Handbook of self-regulation of learning and performance* (pp. 49–64). New York: Routledge.