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EDITED BY
Antonio P. Gutierrez de Blume,
Georgia Southern University, United States

REVIEWED BY
Brian Barber,
Kent State University, United States
Aušra Kazlauskienė,
Vilnius University, Lithuania

*CORRESPONDENCE
Liina Kersna
✉ liina.kersna@gmail.com

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Supporting self-regulated learning in primary education: insights from a Montessori classroom

Liina Kersna[1]*, Liina Lepp[1], Margus Pedaste[1] and Kristjan-Julius Laak[2]

[1]Institute of Education, University of Tartu, Tartu, Estonia, [2]Institute of Computer Science, University of Tartu, Tartu, Estonia

Self-regulated learning is a key component of Maria Montessori's pedagogy, which emphasizes the importance of children managing their own learning process. Several studies confirm that children attending Montessori preschool and school exhibit better self-regulated learning (SRL) skills, but there is less research on what makes the Montessori classroom environment one where students' SRL skills can develop. The aim of this qualitative case study was to identify the characteristics that support SRL in the Montessori classroom based on descriptions provided by Montessori teachers and observations of a Montessori primary classroom. The case study sample included students (N = 18) aged 6–10 from a Montessori-based school's primary learning group and their teachers (N = 2). During the study, the work of the Montessori learning group was observed over the course of one school week, totalling 14 h. Semi-structured interviews were conducted with the teachers before and after the classroom observations. The data were analysed using qualitative content analysis, combining both inductive and deductive content analysis methods. The results show that in the Montessori classroom, learners had several choices regarding what, when, with whom, how, and where they learned, and they had the opportunity to control their learning process, deciding how thoroughly and at what pace they engaged with the chosen task. In addition, learners had the opportunity to solve open-ended tasks and take breaks at appropriate times. Collaboration among students was encouraged in the classroom, and students were given the opportunity to evaluate both their own and their peers' work. Montessori teachers also provided instrumental support to learners, helping them make appropriate choices in their learning and encouraging them to dedicate themselves more thoroughly to the topics they had chosen. The teachers used evaluation practices that supported learning, emphasizing the learner's personal development and goals. The characteristics of a high-SRL classroom were evident in the Montessori classroom.

KEYWORDS

self-regulated learning, student's self-regulation, Montessori pedagogy, classroom observation, primary education

1 Introduction

Research in education has shown substantial evidence that interventions focused on self-regulated learning (SRL) strategies positively influence student achievement (Boekaerts et al., 2000; McCombs, 2017; Nückles et al., 2012; Perry et al., 2015; Zimmerman, 2011). Moreover, several meta-analyses have demonstrated that learning strategy interventions that enhance students' self-regulation and metacognitive awareness lead to improved learning outcomes

(Dignath and Büttner, 2008; Dignath et al., 2008; Hattie et al., 1996). These findings highlight the importance of understanding the mechanisms through which SRL can be effectively fostered in different educational contexts.

SRL involves cognitive, metacognitive, behavioral and motivational-emotional skills that enable students to acquire knowledge and navigate learning challenges (Pintrich, 2000; Zimmerman, 2000). It is a multifaceted and effort-intensive process that requires the development, coordination, and reinforcement of metacognitive knowledge and various learning strategies (Pressley et al., 1987). The term *self-regulated learning* (SRL) is sometimes used interchangeably with the term *self-directed learning* (SDL) (Saks and Leijen, 2014), although there is consensus on their distinct focuses. Both concepts emphasize learners taking responsibility for their own learning by setting objectives, taking steps to achieve them, monitoring progress, and evaluating outcomes (Knowles, 1975; Panadero, 2017; Saks and Leijen, 2014; Zimmerman, 2000). However, the key distinction lies in the level of autonomy involved. SDL is commonly associated with adult lifelong learning and entails creating and managing the broader learning environment, whereas SRL refers to a more micro-level process, typically studied in structured school settings, where tasks and processes are often guided by the teacher (Saks and Leijen, 2014). Therefore, in our study we also focus on SRL.

In school environments, however, supporting students' self-regulation – the ability to independently manage their learning process by setting goals, monitoring progress, and adjusting efforts – is essential for fostering SDL and achieving academic success (Bazurto Alcívar et al., 2024; Jossberger et al., 2010). Therefore, the development of SRL skills not only supports immediate academic progress but also lays the groundwork for learners to become successful self-directed learners (Jossberger et al., 2010).

SRL has been extensively studied in the context of online learning (e.g., Carter et al., 2020; Zuo et al., 2024), particularly during the COVID-19 pandemic, when students transitioned to distance education (e.g., Barrot et al., 2021). These studies have provided valuable insights into the role of technology and remote learning environments in fostering SRL. While SRL processes in traditional classrooms are well documented (e.g., Dignath and Büttner, 2018; Paris and Paris, 2001; Perry, 1998; Perry et al., 2002; Perry et al., 2020; Rosenthal et al., 2024), they have not been more deeply studied in the context of specific pedagogical approaches that explicitly emphasize the development of SRL. Exploring these approaches could offer valuable inspiration for schools aiming to enhance SRL. One such approach, and the most widely implemented alternative educational method (Randolph et al., 2023), is Montessori pedagogy (Lillard, 2019), which is the focus of this study.

1.1 Montessori pedagogy

For Maria Montessori (1870–1952), the founder of Montessori pedagogy, the goal of education was to allow children to develop at their own pace—intellectually, physically, emotionally, and socially. A Montessori school is characterized by an independent learning approach, supported by the teacher's professional guidance, and the use of specialized Montessori learning materials (Marshall, 2017). This approach requires children to move freely within the space and make learning choices that align with their abilities (Lillard, 2017).

A key principle of Montessori pedagogy is that learning should be based on the learner's interests, as engagement enhances learning. Montessori believed that students' learning and satisfaction improve when they have control over their choices, such as what, when, and with whom they study (Lillard, 2017). The learning environment in a Montessori classroom is structured in a way that allows children to engage independently, within clear boundaries, which not only supports their autonomy but also enhance their initiative and concentration (Gentaz and Richard, 2022). In Montessori classrooms, children have the freedom to choose their activities and work at their own pace, which encourages them to set personal goals and monitor their progress (Politi, 2023).

To understand how Montessori schools operate, it is essential to introduce the most important terms used in this context: *work*, *working cycle*, *presentation*, *mixed ages*, *normalization* [Association Montessori Internationale (AMI), 2023]. In a Montessori classroom, learning is referred to as *work*, purposeful activity that enables the child to learn and experiment. A *working cycle* typically refers to a 3-h period, during which the learner can focus uninterrupted on chosen tasks [Association Montessori Internationale (AMI), 2023; Lillard, 2017]. In Montessori classrooms, traditional lessons are replaced by *presentations*, where the teacher introduces new concepts or information to a small group of students, typically 2–5 learners. These presentations focus on guiding students on how to use the available learning materials [Association Montessori Internationale (AMI), 2023]. Through continuous observation, Montessori teachers assess whether a student is ready for the next presentation (Whitescarver and Cossentino, 2008). After each presentation, students are given the opportunity to work independently, without direct teacher guidance [Association Montessori Internationale (AMI), 2023; Lillard, 2017].

Maria Montessori identified four periods of growth, development, and learning in a person's life: 0–6 years, 6–12 years, 12–18 years, and 18–24 years [Association Montessori Internationale (AMI), 2023]. She developed a system of learning materials for children in the 1st and 2nd developmental stages, creating a kindergarten and classroom environment that integrates various subject areas such as language, mathematics, geometry, science, geography, music, art, and practical life skills (Lillard, 2019). This leads to the concept of *mixed ages* – in Montessori classrooms, children of different ages, typically with a three-year age gap, learn together. This usually means that students in a single class are grouped as 6–9 years old and 9–12 years old (Chattin-McNichols, 1992). Montessori believed that a larger class is beneficial for learning as it provides more role models for children to observe. Therefore, in a Montessori classroom, children of mixed age groups learn together, allowing younger students to learn from older ones, as children learn through imitation (Montessori, 1972). The ideal group size, according to Montessori, was 8–13 children of the same age, totalling 24–39 children in one learning group in school (Lillard, 2017). A key principle of Montessori pedagogy is learning with and from peers, which is why children typically work in pairs or self-formed groups (Politi, 2023).

In addition to the already described concepts of work, working cycle, presentation, and mixed ages, Montessori (1952) introduced the term *normalization*, which refers to a child's ability to focus, engage in sustained effort, remain content, and accept both their environment and the people around them. This aligns with research by Ervin et al. (2010), who demonstrated over a three-year study that Montessori education has a positive impact on the development of self-regulation

skills. A similar study with preschool children also affirmed the positive effects of Montessori education on self-regulation (Tiryaki et al., 2021). These findings suggest that Montessori pedagogy incorporates several key principles that may support the development of students' SRL.

However, while normalization emphasizes focus, inner discipline, and harmony as signs of optimal development (Montessori, 1952), it is important to recognize that this ideal may not fully reflect the diverse self-regulatory trajectories of all learners, particularly neurodivergent students. Neurodiversity, understood as a natural and valuable part of human variation, invites more inclusive models of self-regulation that acknowledge different ways of focusing, engaging, and learning (Azuka et al., 2024). From this perspective, the concept of normalization may require a more flexible interpretation to better accommodate the strengths and needs of neurodiverse learners. As Azuka et al. (2024) note, inclusive instructional design that responds to neurodiverse learners' profiles represents a paradigm shift—encouraging educators to build learning environments where all students can express themselves, receive support, and develop their full potential. This aim also reflects Montessori's original vision of education as a means of supporting each child's individual growth (Montessori, 1952).

1.2 Supporting SRL through Montessori practices

It is important to note that self-regulation is a skill that can be developed and trained (Blair and Raver, 2015; Zimmerman, 2000, 2002). Research by Perry (1998), Perry et al. (2002), and Perry and VandeKamp (2000) has demonstrated that even young children (aged 6–10) can engage in complex activities requiring self-regulation when supported with appropriate teaching practices. Montessori (1952) followed a similar principle, emphasizing that children achieve independence and self-regulation when provided with a carefully prepared environment, specialized materials, and teacher guidance.

Perry (1998), Perry et al. (2002, 2020), and Perry and VandeKamp (2000) have identified key characteristics of high-SRL classrooms, including opportunities for choice, control over challenges, self- and peer-assessment, instrumental support from teachers and peers, and teacher evaluation practices. Similarly, Montessori's concept of normalization, which reflects a child's ability to focus, engage in sustained effort, and develop autonomy, is nurtured through freedom of choice, self-paced learning, and constructive feedback from teachers [Association Montessori Internationale (AMI), 2023; Montessori, 1952]. These elements closely align with high-SRL classrooms as described by Perry et al. (2002) and Dignath and Veenman (2021). The previously mentioned process of normalization may also be interpreted through Efklides' (2011) Metacognitive and Affective Model of SRL (MASRL), which emphasizes the dynamic interplay between cognitive regulation and emotional-motivational experiences during task engagement. The child's ability to remain focused and motivated in self-directed activity reflects the role of metacognitive experiences, such as perceived difficulty and satisfaction, which can drive or hinder SRL depending on the context. For example, in Montessori classrooms, students select activities from a prepared environment, allowing them to set personal goals, monitor progress, and adjust their efforts – key components of SRL (Politi, 2023).

Research highlights that SRL can be implemented both through explicit teaching of learning strategies and through classroom environments that promote autonomous practice (Kistner et al., 2010). Montessori classrooms integrate these approaches by combining structured teacher guidance with opportunities for independent work. Teachers scaffold learning through presentations, guided instructional sessions for small groups [Association Montessori Internationale (AMI), 2023]. Afterward, students work independently, applying what they have learned (Lillard, 2017). These practices are also consistent with Winne's (2011) cognitive model of SRL, which describes self-regulation as a recursive cycle involving task definition, goal setting and planning, enacting learning strategies, and adapting based on self-monitoring.

Another defining feature of high-SRL classrooms is collaborative learning, where peer interactions support shared problem-solving and social regulation of learning (Perry et al., 2002; Perry and VandeKamp, 2000). Montessori classrooms exemplify this principle through mixed-age groups, where younger students learn from older peers, and collaboration is encouraged in pairs or small groups (Lillard, 2017; Montessori, 1972). Peer assessment and teamwork, central to Montessori pedagogy, align with Dignath and Veenman's (2021) emphasis on collaborative dynamics and strategic teacher interventions. The principle of constructive learning, as outlined by Dignath and Veenman (2021), also resonates with Montessori's focus on task complexity and active engagement. Montessori materials encourage hands-on, purposeful activities that activate prior knowledge, challenge students to explore multiple solutions, and promote independent problem-solving (Gentaz and Richard, 2022; Politi, 2023). This reflects Perry et al.'s (2002, 2020) emphasis on tasks that foster active problem-solving and self-assessment.

Instrumental support from teachers and peers, a cornerstone of Montessori pedagogy and high-SRL classrooms (Perry et al., 2002, 2020), is strongly emphasized by Montessori teachers. They provide ongoing observation and process-based evaluation, encouraging students to view mistakes as learning opportunities (Choi, 2024; Tiryaki et al., 2021). Scaffolding plays a crucial role in enhancing learners' task focus and metacognitive engagement, reinforcing SRL (Li et al., 2023).

The characteristics of high-SRL classrooms – student choice, control over learning challenges, self- and peer-assessment, and instrumental support—align with four SRL strategies: cognitive, metacognitive, behavioral, and motivational (Sins et al., 2024). Cognitive strategies involve knowledge construction (e.g., activating prior knowledge, summarizing, problem-solving), while metacognitive strategies focus on planning, monitoring, and reflection. Behavioral strategies include resource management, help-seeking, and feedback use, and motivational strategies enhance self-efficacy, focus, and persistence (Dignath and Veenman, 2021; Sins et al., 2024; Zimmerman, 2000).

In contrast, low-SRL classrooms, as described by Perry et al. (2002), often lack autonomy, collaboration, and meaningful engagement. These environments, characterized by rigid teacher control and procedural guidance, stand in stark contrast to the dynamic practices of Montessori classrooms (Montessori, 1972), which foster autonomy, collaboration, and active learning. Montessori pedagogy exemplifies high-SRL principles through its emphasis on

student choice, collaborative learning, and intrinsic motivation (Gentaz and Richard, 2022; Lillard, 2017; Politi, 2023). These principles offer valuable insights for other schools seeking to foster SRL.

These characteristics also align with Perry et al.' (2020) four macro categories defining SRL-supportive classrooms: SRL-supportive structures, student influence/autonomy, scaffolding/co-regulation, and community. Macro categories include micro-level practices that teachers use to enact these emphases. SRL-supportive structures establish routines, meaningful tasks, clear expectations, and visual cues to promote independent and collaborative learning. Student influence and autonomy allow learners to make choices, regulate their pace, and self-assess, while teachers balance autonomy with instructional goals. Scaffolding and co-regulation involve teachers, peers, and tools providing support through modelling, metacognitive questioning, feedback, and motivational strategies. Community and collaboration foster belonging and shared learning, where teachers and students co-construct knowledge and support one another. Together, these elements enhance student agency, motivation, and self-regulation (Perry et al., 2020).

A growing body of research highlights the positive impact of Montessori education on children's self-regulation and autonomy, suggesting that its pedagogical principles create an environment conducive to SRL. Previous research has shown that children attending Montessori-based preschools exhibit better self-regulation skills compared to children in the control group (Tiryaki et al., 2021). Compared to traditional schooling, Montessori students, even at an early age, demonstrate strong self-regulation skills, such as the ability to identify and correct their own mistakes independently (Denervaud et al., 2019). Observations in upper Montessori classrooms (ages 9–11) further highlight how teachers foster autonomy by offering students choices in tasks and learning partners (Koh and Frick, 2010). By focusing on the learning process rather than just the outcome, teachers promote critical thinking, self-regulation, and a sense of community responsibility (Choi, 2024; Tiryaki et al., 2021). These findings suggest that Montessori classrooms create conditions that support SRL.

However, despite these findings, to the best of the researchers' knowledge, no study has systematically examined which specific characteristics of a high-SRL classroom (Perry et al., 2002) are present in Montessori schools. This study addresses this gap by providing deeper insights into how Montessori classrooms foster SRL. The findings contribute to a better understanding of how these characteristics function in practice, offering guidance for educators across various educational contexts and advancing theoretical discussions on operationalizing high-SRL classroom characteristics. Given this gap in research, the primary school level was selected for this study because previous research (Morrison et al., 2010; Perry et al., 2002) has demonstrated that supporting SRL at an early school age yields positive results, fostering long-term self-regulation development and enhancing students' ability to manage their learning. This study focuses on the primary group in a Montessori school, where children aged 6–10 learn together, as Perry (1998), Perry and VandeKamp (2000), and Perry et al. (2002) have shown that children in this age range are capable of regulating their learning when provided with an environment that supports SRL.

Perry (1998), Perry et al. (2002, 2020), and Perry and VandeKamp (2000) high-SRL classroom framework provides a practical lens for analysing how key characteristics are aligned to create classrooms that support SRL. Developed based on long-term studies, this framework has also been applied in previous qualitative research focusing on SRL in a common classroom that does not apply a specific pedagogical approach (see Kersna et al., 2025). Therefore, it serves as the foundation of the current qualitative case study, which examines the characteristics of Montessori classrooms that foster SRL, as described by Montessori teachers and observed in a Montessori primary classroom. To achieve this aim, this study addresses the following research question: What characteristics of Montessori primary classrooms support self-regulated learning, as perceived by Montessori teachers and observations in the classroom?

2 Materials and methods

This research was conducted as a case study, which is characterized by rich and in-depth data collection (Creswell and Poth, 2018). The focus is on a Montessori pedagogy-based primary learning group (a mixed-aged class, combining grades 1–3) and their teachers.

2.1 Participants

The participants of the study were teachers of the Montessori primary learning group ($N = 2$) and their students ($N = 18$) in one school in Estonia. The Montessori teachers involved in the case study held a master's degree in accordance with the teacher qualification requirements in Estonia and had completed the internationally recognized 2-year training programme by the Association Montessori Internationale (AMI). At the time of the study, they had one and a half years of experience as Montessori teachers.

The learning group we observed comprised 18 children. Just before the observation, three new children had joined the group: two came from a kindergarten, and one transferred from the same school's secondary level learning group. The remaining 15 children had been working together since the beginning of the school year, for about six months. The learning group included one 3rd grade boy who was 10 years old, and two children from the 2nd grade. The remaining members of the observed learning group were in the 1st grade. In the Montessori learning group, first graders are 6 years old and turn 7 during the school year. So, the observed learning group consisted of 15 children aged 6–7, while the remaining three children were 8–10 years old. Four children had not attended a Montessori kindergarten but had been enrolled in a Montessori pre-primary school for one year.

2.2 Data collection

The data were collected using interviews and observations. Interviews were conducted with the teachers participating in this study on two occasions: before and after the observation. The pre-interview, conducted as a semi-structured interview, focused on the teachers' descriptions of what a Montessori classroom day looks like (e.g., questions about how the school day begins, the different stages of the day, and how it ends) and the activities that support SRL, according to the teachers' opinions (e.g., questions about what choices students can make in their learning process, how students are guided

towards collaboration, how goal setting and reflection on learning take place, and what evaluation practices are used, such as "How does a child receive feedback on what they already know and what they still need to practise?"). The semi-structured interview guide was designed based on the characteristics of a high-SRL classroom (Perry et al., 2002). The post-observation interview was conducted as an unstructured pair interview (Lepik et al., 2014). The pair interview format was chosen for the follow-up interview so that the teachers could complement each other by discussing the observed days. Clarifying questions were asked in the follow-up interview regarding the observations made. For example, the teachers were asked to explain why they intervened or did not intervene in the children's activities, why some children took breaks, and so on.

The interviews were conducted in the teachers' own classrooms. The pre-interviews took place two days before the observations began, in February 2024. Both pre-interviews lasted approximately 60 min. The follow-up interview, conducted with the teachers in the classroom on the last day of the observation week, lasted 1 h and 13 min. With the participants' consent, the interviews were recorded. The interviews were fully transcribed, with the names of the teachers and other identifiable data replaced by pseudonyms in the study. The total length of the transcriptions was 152,024 characters, including spaces.

The study employed unstructured observations, meaning no predefined criteria were set (Vihalemm, 2014). This approach enables a deeper understanding of complex behaviors and relationships that structured methods may not fully capture (Cohen et al., 2018). Each observation day protocol began with a description of the classroom, such as how many children had arrived in the learning room by a specific time, what was written on the board, how the desks were arranged in the room, etc. (example from the beginning of an observation protocol: "15 children and two teachers are present"). Observations were done by two researchers (on one day by three). The two observers described the activities taking place in the classroom as precisely as possible in the observation protocol, separating them with timestamps and presenting them as actions of the teacher and students (e.g., "9:55 – The teacher is making notes about the children"). In addition, quotes from conversations between the students and the teacher were also written down (e.g., "9:48 – 'I do not know what to do,' says one child to the teacher").

The features important for the study were defined after the observation, during the analysis process (see more in the data analysis subsection). The presence of the observers was public, but they remained in the background and did not interfere with classroom activities, aiming to minimise their impact on the learning environment. To reduce observer bias, both researchers kept separate field notes during observations and engaged in daily discussions to calibrate their interpretations and ensure shared understanding. The observers focused exclusively on systematically documenting classroom practices and learner-teacher interactions.

Since the activities took place mostly in two rooms, the observers divided themselves between the two rooms. In total, four school days were observed from Monday to Thursday, during which the working time took place between 9:00 and 12:00. The total observation time amounted to 840 min, as we also observed a recess and a music lesson on one day in addition to the working time. The observation protocols contain a total of 159,008 characters with spaces.

Although the observation period covered only four school days, the researchers considered it sufficient due to the consistent daily structure of the observed Montessori classroom. The observed week included all core elements of the instructional cycle – presentations, experiments, individual work, and teacher-student dialogues – providing a representative data of typical classroom practices. The teachers also confirmed in the interviews that the observed week was a good representative of regular weeks in the Montessori classroom.

2.3 Data analysis

The data were analysed using qualitative content analysis, combining both inductive and deductive content analysis methods. The data analysis was conducted using the QCAmap[1] data analysis platform, based on the content analysis guidelines by Mayring (2020). In the interview transcriptions and observation protocols, meaningful units were first identified using deductive analysis (Mayring, 2020), based on the characteristics of a high-SRL classroom (see Appendix Table 1). Subsequently, the established categories were analysed inductively, leading to the formation of subcategories. For instance, the meaningful unit from the interview, "When we meet with this child every two weeks, we talk for about 15–20 min about their learning progress, challenges they have encountered, and strategies they can use to improve," was first coded deductively under "self- and peer-assessment." The same category's meaningful units were then grouped and analysed inductively, leading to the subcategory "reflecting on their learning with the teacher." During the coding and categorization process, a researcher diary was used, where a description of the study process was recorded, including decisions related to the coding choices.

To ensure transparency and rigor in the analysis process, a researcher diary was maintained to document decisions related to coding and categorization. Two researchers were involved in analysing the qualitative data: the first author coded all classroom observation protocols, while one of the co-authors coded the interview transcripts. To enhance the quality and consistency of the analysis, the first author also co-coded one interview transcript. A reciprocal co-coding procedure was implemented, whereby both coders – the first and fourth authors – independently analysed the same interview and one day of observation data. They then met to compare their coding, resolve discrepancies through discussion, and iteratively refine a shared codebook containing code definitions, inclusion and exclusion criteria, and illustrative examples. The finalized codebook (see Appendix Table 1) was systematically applied to the entire dataset.

Agreement between the coders was assessed conceptually by examining whether the coders applied the same codes to thematically similar segments. This approach is consistent with Creswell and Poth's (2018) emphasis on collaborative and iterative coding practices that strengthen the credibility, dependability, and analytical rigor of qualitative research.

A reflexive stance was maintained throughout the study. All researchers had professional backgrounds in education and prior experience with student-centred learning environments. They acknowledged that this background may have influenced their interpretations of classroom practices, particularly in how

1 https://qcamap.org

self-regulated learning behaviors were identified and categorised. At the same time, the authors had no prior personal or professional affiliation with Montessori pedagogy, which enabled a more independent and open-minded stance in interpreting the observed practices. Regular reflective discussions were held between the authors to identify and address potential biases and to ensure that the analysis remained grounded in the data.

The results will be presented with excerpts from the interview transcriptions and observation protocols. Unnecessary repetitions and filler words will be removed from the interview excerpts. The omitted parts from the quotes and descriptions in the observation protocols will be marked with ellipses. At the end of each data excerpt, the source of the data will be provided (e.g., interviews were coded as "INT1," "INT2" for teachers; observation protocols as "OP").

2.4 Ethical considerations and informed consent

The study was approved by the Ethics Committee for Human Research at the University of Tartu (approval number 382/T-6, obtained on October 11, 2023). After obtaining approval from the ethics committee, a request was made to the school principal to allow the study to be conducted at the school. After receiving the school principal's consent for the school's participation in the study, the principal provided the researchers with the contact details of the teachers who had agreed to participate and share their contact information with the researchers. The teachers were contacted via email, where the purpose of the study and its implementation in the classroom were explained in more detail. Participation in this study was voluntary for the teachers. All teachers who participated signed a written informed consent form. Teachers who agreed to participate were asked to send an invitation to the parents of the children in the learning group, along with an informed consent form for the parents regarding the children's participation in this study. The child and the parent were asked for consent to conduct the observation. All children in the learning group and their parents provided written consent for the study to be conducted.

2.5 Context

In the Estonian education system, where the study of this article was conducted and where compulsory schooling spans from age 7 to 18 (Riigi Teataja, 2024), parents play a central role in shaping their children's educational pathway. According to the Constitution of the Republic of Estonia (1992), parents have the right to decide on their children's education, including the choice of the most suitable philosophical or pedagogical approach. This principle has supported the development of a diverse school landscape that includes state, municipal, and private schools. Across all school types – regardless of ownership – teachers and school leaders enjoy considerable autonomy in organizing instruction and selecting teaching materials (OECD, 2019a).

The Estonian National Curriculum for Basic Schools (2011) highlights the importance of learning competence – defined as the ability to organise one's learning individually and with others, seek and apply information, plan and follow through with studies, transfer knowledge to new contexts, and reflect on one's skills, motivation, and confidence to identify future learning needs. This emphasis is reflected in student outcomes: in addition to strong academic performance (OECD, 2019b, 2023a), Estonian students also report high levels of self-regulated learning and growth mindset. Nearly 70% of 15-year-olds say they are capable of managing and directing their own learning – placing Estonia among the top-performing countries in this regard (OECD, 2023a).

The assessment system is flexible: until grade 6, students may be evaluated using descriptive feedback, but starting from grade 7, these evaluations must be converted into numerical grades on a five-point scale to ensure national consistency (Riigi Teataja, 2024). The Estonian National Curriculum for Basic Schools (2011) also emphasises the importance of involving students in self- and peer-assessment to develop their ability to set goals, analyse their learning and behavior based on these goals, and increase their learning motivation. The curriculum also highlights the use of portfolios as a formative assessment tool, enabling students to document and reflect on their learning processes.

The study was conducted in an AMI-affiliated Montessori school in Estonia, which operates as a private school under the national curriculum. During the data collection period, the school had two learning groups: grades 1–3 and 4–6. This study focused on the 1–3 grade group and their teachers. School days began at 9 a.m. and continued without a shared break until noon, known as work time. Each morning, the instructors had written up to five scheduled presentations on the board, along with the names of the children expected to attend each presentation (example from the observation log: "9:15 – Timeline of Humanity: 6 children's names; 9:50 – Pronouns: 3 names; 10:20 – Measurement: 3 names; 10:50 – Adjectives: 6 names; 11:15 – Place Value: 4 names"). During the presentations, the instructors introduced a specific topic to the learners, whose name was displayed on the board that day. Both instructors conducted the presentations, which typically lasted around 20 min, and participation was mandatory for the children; these were held separately, in different rooms. Between presentations, the children could work on tasks of their own choosing. After the work period, they had a communal meal and a one-hour outdoor recess, followed by non-Montessori classes, such as music, physical education, and English as a foreign language.

Fridays, which were independent learning days at the Montessori school, were excluded from the observation as they took place at home. The goals and activities of the independent learning days were discussed with the instructors during the interviews.

The learning group operated in two interconnected rooms. The larger room had a big table for group work, smaller tables, shelves with Montessori materials, and student drawers for ongoing tasks. The centre was left open for floor work using mats. A small kitchen allowed children to get drinks and wash dishes, and meals were also held there. The smaller room had a table for individual or paired work, a larger round table for presentations, and space for discussions with teachers. A wall with large windows separated the rooms, with an open door for free movement.

Children were assigned weekly housekeeping tasks. The tasks, along with a descriptive image and specific instructions, were hung on the wall of the learning room. Each task had the names of two children indicated, who were responsible for those tasks. Shared tasks included: caring for stationery, washing dishes and cleaning the kitchen,

emptying the dishwasher, cleaning the tables, preparing lunch, cleaning the floors, emptying the trash cans, dusting, and cleaning the blackboard and mats.

3 Results

This section outlines the findings that respond to the research question: What characteristics of Montessori primary classrooms support self-regulated learning, as perceived by Montessori teachers and observed in the classroom? The data were analysed using qualitative content analysis following a primarily deductive approach, based on the theoretical framework of SRL (Perry et al., 2002). The main categories derived from Perry et al. (2002) framework (see Appendix 2), which guided the deductive data analysis, form the basis for the presentation of the results. Each main category is further divided into subcategories, which emerged inductively from the data, to illustrate the nuanced ways in which the characteristics of SRL are manifested in Montessori classrooms. The findings are presented according to these main categories and subcategories. Specifically, the findings highlight how Montessori teachers perceive these characteristics and how they are enacted in the classroom, based on both interviews and observations.

The results indicate that students had extensive opportunities to make choices in organizing their learning, control over the level of challenge, opportunities for self- and peer-assessment, and received instrumental support from both teachers and peers. Additionally, teachers' evaluation practices were designed to support students' personal development and learning goals. Below, we provide a more detailed overview of each category and its related subcategories (see Figure 1).

3.1 Choice options

In the Montessori classroom, students had several opportunities for choice. The data analysis identified six subcategories under the theme of choice: choice of what to learn, choice of how to learn, choice of task sequence, choice of learning location, choice of learning partner, and choice of the final format for the task outcome.

3.1.1 Choice of what to learn

Based on the interview and observation data, it was found that the students could choose the subject and task they wished to work on at a time that suited them during the school day. As a teacher stated in the interview:

> "What he chooses and which subjects and how he does them depends on the child – on what interests him the most at the moment." INT1

Based on the observation data, the learners received an overview in the morning of which presentations they were scheduled for, and for the rest of the time, they were able to focus on the subjects and tasks of their choice. Excerpt from the observation protocol:

> "9:08 – 'Everyone thinks in their head about what work they are going to do, and once you have figured it out, you go and pick up your task,' says the teacher." OP

The interviews with the teachers revealed that the opportunities for choice are not endless, and there are skills that must be practised. New knowledge is shared through presentations, after which the teacher introduces various ways for learners to reinforce and practise the new knowledge. Montessori classrooms offer multiple opportunities for practice, the teacher explained.

> "At the end of each presentation, I suggest follow-up exercises." INT2

3.1.2 Choice of how to learn

In the observed Montessori classroom, children had the freedom to choose from various learning methods and materials. The teacher explained that different materials are introduced during presentations, allowing students to select their preferred approach later. For instance, in mathematics, children could use an abacus, beads, worksheets,

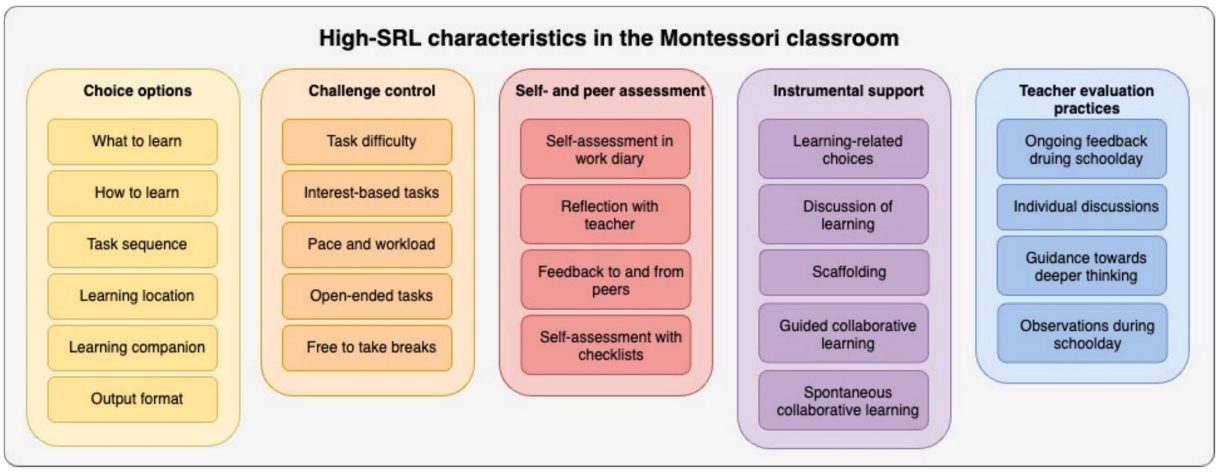

FIGURE 1
High-SRL characteristics in the Montessori classroom.

puzzles, geometric shapes, or word problems. Similarly, in YY, they could practise letters, classify words, read, or write their own book. History learning involved painting cave art, creating timelines, or reading, while science lessons included research projects presented as posters.

> "One child is solving math problems with beads on the floor, while the others are gathered around the table learning a large initial letter and working on drawing the map of YY." OP

Learners who wished to quietly concentrate in the open classroom were able to use noise-cancelling headphones, which were used repeatedly during the observation days.

> "Two children take headphones from the shelf and use them to better focus on their tasks." OP

3.1.3 Choice of task sequence

In the Montessori classroom, children were able to choose the order in which they completed tasks. The teacher mentioned in the interview that at the start of the school day, the learner can choose what to begin with and decide what they want to work on that day:

> "The student chooses the work for themselves." INT1

The observation data also showed that the learner had the freedom to decide which tasks to work on during a specific school day, which tasks during the week, and which tasks throughout the academic year. At the beginning of the school day, the children noted in their work diaries which tasks they wanted to focus on that day. Ongoing tasks were placed in the learner's named drawer.

3.1.4 Choice of learning location

In the Montessori classroom, children had the option to choose where they would work during the school day. For example, learners could work on the floor, using a mat, work individually in a reading corner, or at a desk. Additionally, students had the opportunity to learn at a large table, where some children worked individually on their tasks, while others solved tasks collaboratively. Example from the observation protocol:

> "The students take the mats and place them on the floor to start working. Meanwhile, other children are sitting at the table, where they can focus more quietly on their tasks." OP

Regarding choices related to the learning location, the interview highlighted that students had the opportunity to go on field trips related to topics of interest, which the child organized themselves. Thus, learning can also take place outside the classroom if there is interest in a specific topic.

> "'Going out' is the term in the Montessori curriculum, where the child organizes the outing themselves." INT2

3.1.5 Choice of learning partner

In the Montessori classroom, students had the opportunity to choose who they worked with. Throughout the school day, children collaborated with different peers. For example, learners discussed with each other whom they would work with on the poster or who they would pair up with to solve math problems.

> "The child wants to make a mammoth-themed poster and asks a peer for help. Together, they start exploring the shape of the mammoth and creating a presentation from it." OP

At the same time, the observation showed that the learner had the option not to collaborate with a peer if they did not wish to and it was accepted by the peer and the teacher.

> "The teacher says that K is going to make a mammoth poster. 'Would you like to join?' asks the teacher. The student replies, 'No.'" OP

According to the teacher, the choice of who a student works with is based on personal preference, a shared challenge, or the student's need to practise something in which another student is an expert. Additionally, the teacher notes in the interview that they encourage students in the classroom to ask each other for help:

> "…they go and ask the other child, 'I want to do this task with you.'" INT1

The teacher further explained the choice of learning partner in the interview, stating that the choice of a learning partner is accepted as long as the pairing works, according to the teachers' assessment. Otherwise, they are directed to work separately.

> "Some groups simply may not be well-suited as work partners. They might be great friends, but their collaboration does not run smoothly. …This applies only in cases where it is evident that collaboration is not working." INT2

3.1.6 Choice of final task format

In the Montessori classroom, children were able to choose how they presented the results of their work. Based on the observation data, learners had the opportunity to present their knowledge by writing their own books, presenting visual projects (e.g., posters, maps), writing about their work in their work diaries, using drawing sheets, or conducting research projects.

> "The teacher offers the children the opportunity to choose how they wish to present their knowledge, either by writing in a notebook or drawing, for example, a poster." OP

According to the observation data, teachers allowed children to choose the format of their work presentation themselves, avoiding directing them toward any particular format.

3.2 Challenge control

In the Montessori classroom, children were provided with various opportunities to control their challenges. The data analysis identified five subcategories under the theme of controlling challenges: engaging with a more difficult task, focusing on a personally interesting task, determining their own pace and

workload, working on open-ended tasks, and taking a break at a time that best suits the learner.

3.2.1 Engaging with a more difficult task

In the observed Montessori classroom, students engaged with tasks of varying difficulty levels based on their skills and readiness. The classroom allowed students to select increasingly difficult tasks if they wished. For example, all students had access to a box of addition, subtraction, multiplication, and division problems and could select tasks to solve. Children could also create their own problem-based tasks.

> "One girl wants to go and do some calculations. The teacher says that if she wants, she can also come up with her own problems." OP

In the interview, the teacher confirmed that the difficulty of the tasks depends on the child's level of knowledge and skills. When learning new skills, the learner progresses through different stages, which become increasingly difficult over time:

> "It also depends on the child, whether they do all ten steps that are included in the sequence, or if they pick it up very quickly and it becomes boring for them, in which case we skip some steps." INT2

3.2.2 Focusing on a personally interesting task

In addition to more challenging tasks, the observed Montessori classroom also encouraged learners to focus on tasks that were of greater interest to them.

> "'You had a greater interest in mammoths, I saw that you were reading,' says the teacher to the learner. The learner expresses an interest in prehistory, telling the teacher that they have made books about Vikings." OP

Teachers explained that Montessori learning is aligned with children's interests. When a child is engaged in a topic, they can focus on it calmly, with efforts made to connect it to other subjects. As one teacher noted, allowing students to explore their interests enhances their motivation to learn.

> "The keyword here is making use of interest, because once you hit that interest, they will solve everything for you …" INT1

In the interview, the teacher added that sometimes learners create new tasks based on what is happening in the learning environment. For example, the students discovered ants in the classroom, which sparked a deeper interest in the ants' way of life, inspiring the learners to create a research project about ants.

> "If it happens to be a challenging task for them, then we do not say anything, but if they spend hours doing nothing and just run around with the ants, that's where the limit is." INT2

The teacher described in the interview that a learner engaged with a topic of interest is motivated to learn, they are happy, and ready to put in greater effort and focus for a longer period of time:

> "It's just that feeling of flow, but you can see it. They focus on one thing, and they are happy doing it." INT1

In the interviews, the teachers explained that in collaboration between the school and home, Fridays in the observed Montessori learning group were designated as independent learning days, which are also intended for learners to delve deeply into topics based on their interests.

3.2.3 Determining their own pace and workload

In the Montessori classroom, students controlled the pace and extent of their work. Observations showed varying time and effort dedicated to tasks. Each child attended 1–2 presentations per session and could work on chosen tasks freely. Some completed tasks quickly and moved on, while others focused on a single task for over half an hour. The teacher also confirmed in the interview that the student can decide how long, or at what pace, they solve tasks:

> "If the child wants to do math, let them go ahead. I will not tell them that this is their limit." INT1

In the interviews, the teachers highlighted that learners have the option to leave tasks unfinished. The unfinished tasks were kept in the learner's named drawer, and they could choose to continue working on them whenever it suited them.

> "[In the students' personal] drawers, there are unfinished tasks. Their work diaries are also there. If they have started a research project and do not finish it all at once, it is kept in the drawer." INT1

In the interviews, the teachers pointed out that, in addition to being able to choose how long a student works on a particular topic or task during the school day or week, the student can also decide how long they wish to focus on their chosen topic throughout the school year:

> "We had the first big story here, which we talked about in the first week, and there were some experiments, and they are still doing them [six months later]." INT2

In the observed Montessori classroom, both open-ended (see more about open-ended tasks in subsection 3.2.4) and closed tasks were represented. As closed tasks, for example, children could practise writing letters and numbers, as well as solve given operations with an abacus and do thematic sorting tasks, such as grouping nouns and verbs. Also, in solving closed tasks, learners had the option to choose the pace and volume of task completion.

3.2.4 Working on open-ended tasks

Learners in the observed classroom engaged in open-ended tasks. Some compiled their own books, adding to them throughout the week, while others created posters, presentations, experiments, or artwork (e.g., painting cave art on A3 paper). They summarized books in decorated notebooks and tackled both standard exercises and complex word problems in mathematics. In the interview, a teacher explained that the tasks could be open-ended:

> "We do it this way: the more creative the approach – not something I dictate in detail – the better. So, I try to give them very general [guidelines] at the beginning." INT1

3.2.5 Taking a break at a time that best suits the learner

In the observed Montessori classroom, there were no fixed break times, but students could take breaks as needed. A teacher explained that learners could rest, walk around, or do lighter activities like drawing or reading between challenging tasks. If resting in the hallway, they had to inform the teacher.

> "This three-hour work cycle is something that happens in the classroom, and those breaks are natural." INT1

The observations revealed that there were a couple of children in the learning group who were allowed to regularly leave the classroom for a break along with their snack. A 5, 10, or 15-min sand clock was provided to the child to measure the break.

> "10:17 – The teacher sends one boy on a 15-min break, giving him a sand clock and a granola bar. The child goes to the corridor." OP

3.3 Self- and peer-assessment

In the Montessori classroom, children were offered various opportunities for self-assessment, as well as peer assessment. The data analysis identified four subcategories: self-assessment in the work diary, reflecting on their learning with the teacher, providing feedback to each other in collaborative learning, and self-control using learning materials.

3.3.1 Self-assessment in the work diary

Students filled out daily work diaries, noting planned and completed tasks, including presentations and independent work. The teacher explained that this practice fosters students' reflection on their learning and achievements. According to the teacher, regular use of the diary allows students to track their progress, review completed tasks and identify what still needs to be done.

> "Some children have adopted this so well that they always have everything written down. Some children fill it out at the end of the work time when I tell them to think about what they did." INT1

3.3.2 Reflecting on their learning with the teacher

At the end of the school day, students reflected on their learning with the teacher, reviewing their work diaries. They discussed planned, completed, and unfinished tasks while analysing their learning, behavior, and mistakes. Example from the observation protocol:

> "The children go to the teacher to talk about what they did. One child admits that during the experiments, they were chatting." OP

In the interview, a teacher explained that in these conversations, they try to encourage the learner to think about their learning, analyse themselves, and set goals:

> "We ask them how they feel, whether they think we have reached the goal." INT1

In the interview, the teachers emphasized that one of the key goals of these conversations is to guide the learner in setting goals, the progress of which can be followed in subsequent discussions. According to the teachers, it is important to have concrete agreements with the student on how they will achieve their goals.

> "It is written down for her, and it is written down for me as well, that she is now practising a specific thing. … And when we meet in two weeks, we will review if she really practised it." INT2

Based on the observation results, learners were able to continuously assess their work, for example, deciding whether they considered their work finished or if they felt it still needed improvement. Example from the observation protocol:

> "The teacher asks the child if they want to make any additions or not. If the child does not want to, the work is placed in the completed tasks pile." OP

3.3.3 Providing feedback to each other in collaborative learning

In the observed Montessori classroom, collaborative learning was encouraged, during which learners gave feedback to each other. For example, when a child studying at a shared table noticed that their peer wrote a number incorrectly, they pointed out the mistake to their classmate. Examples from the observation protocol:

> "'Wait, listen, you have the 6 upside down,' notices the child." OP

In the interviews, the teachers emphasized that in the Montessori classroom, it is encouraged and common for learners to provide each other with continuous feedback:

> "Actually, the children also give each other feedback. … For example, a student who is already better at reading or writing gives feedback to others." INT1

3.3.4 Self-control using learning materials

Based on the interviews, the subcategory of self-control using learning materials emerged. The teachers explained that the Montessori method is designed in such a way that the child can learn from their own mistakes by discovering and correcting them independently. Some Montessori learning materials are built with self-correction in mind, allowing the learner to sense whether something is missing or incorrect, a teacher explained:

> "Some materials come with control sheets, depending on the task. … When it comes to sensory materials, often the material itself provides feedback. …and eventually, the learner realizes that two pieces do not match, so they begin to search for where the mistake occurred." INT2

3.4 Instrumental support

The data analysis identified five subcategories under instrumental support: the teacher helps make learning-related choices; the teacher initiates discussions about learning; the teacher uses scaffolding; the teacher guides students toward collaborative learning; and students spontaneously collaborate and support each other.

3.4.1 The teacher helps make learning-related choices

In the observed Montessori classroom, the teachers helped learners make learning-related choices. For example, based on the observations, the teachers assisted learners in choosing between unfinished tasks in their drawers to continue working on. They also helped learners make learning-related choices when the learner asked for assistance. Example from the observation protocol:

> "The girl tells the teacher that she does not know what to do. The teacher asks which presentations she has attended. They go together to the learner's drawer and look through the contents. … They find the worksheet for practising linking words. The child agrees to do it." OP

Based on the observation data, the teachers monitored the learners' activities, and when they noticed that a child needed help with making learning-related choices, the teachers proactively offered support in making those choices. Example from the observation protocol:

> "The teacher approaches the girl: 'You have a good free moment right now, would you like me to show you the number sequence?' The child agrees." OP

The teachers explained in the interviews that learners are encouraged to choose challenging tasks, and if a learner is unable to decide, the teacher suggests what the child could work on.

> "We also say that we learn here at school and choose challenging tasks for ourselves, and if they do not choose a challenging task, we choose for them." INT1

3.4.2 The teacher initiates discussions about learning

In the observed Montessori classroom, the teachers systematically discussed the learners' progress with them at the end of each school day's work period and held more in-depth discussions every two weeks. After the three-hour work period, one of the teachers would have a personal conversation with each child every school day, reviewing the tasks completed during the work period, which we briefly described under "self- and peer-assessment." The learners had written their completed tasks in their work diaries, and the teacher had also made notes throughout the day about each child's work. During the conversation, the teacher discussed with the learner what they had planned to do and what they had actually accomplished.

> "'Did you do the tasks we talked about in the morning?' asks the teacher. The child replies that they did not do everything, for example, the abacus. They promised to do it tomorrow because it needs practice." OP

Teachers engaged in ongoing discussions with students about their learning throughout the day, including upon arrival at school. Observations showed that teachers moved around the classroom, checking in with students and asking about their progress. Interviews highlighted the key role of teacher-student dialogue in the Montessori classroom, where teachers guide students in self-assessment, goal evaluation, and setting new learning objectives.

> "I ask the child how they feel about it, whether they think they need to practise handwriting more, and what we should do about it. This is the point where we agree that more practice is needed." INT1

3.4.3 The teachers used scaffolding

Based on the observation data, the teachers in the Montessori classroom used scaffolding, a form of support that decreases over time as the learner's need for assistance diminishes, by demonstrating different activities to the learners, such as practising writing letters and numbers or counting numbers. Example from the observation protocol:

> "(The student) goes directly to the teacher and asks how to write the letter G. The teacher takes the board and writes G in the connecting letter style, and the boy continues working independently on practising writing the letter G." OP

In addition, the observation revealed how the teachers demonstrated a sequence of actions for the learners to successfully complete a task, which the students then applied themselves. For example, the teacher demonstrated how to create a measurement template using their foot and how it could be used for measuring.

> "The teacher measures the table with their foot template, and the children watch. … All the children start measuring different things with their foot templates." OP

3.4.4 The teacher guided the learners towards collaborative learning

The observed Montessori teachers guided the children towards collaborative learning, allowing them to provide support to each other in their learning process. The teachers encouraged the learners to turn to their peers with questions or requests for help during the school day, providing opportunities for them to learn together.

> "'If you want, you can work together,' says the teacher. … Two girls decide to work in pairs." OP

Based on the observation data, the teacher guided learners who decided to collaborate to make agreements with each other before starting their joint work, outlining how they would work together.

> "'Discuss among yourselves how you'll do it, because you are working together,' says the teacher." OP

In the interviews, the teachers explained that they would consciously guide students to learn together and teach each other, for example, having older students mentor younger ones, so that the older learner can consciously take on the role of a guide.

> "Sometimes the older student guides the younger one, and that's how it works. …It works this way, and I sometimes encourage it myself." INT1

3.4.5 Learners collaborate spontaneously and support each other

In the observed Montessori classroom, learners collaborated and supported each other on their own initiative. In the interviews, the teachers explained that in Montessori pedagogy, learning materials, the teacher, and learning from and teaching peers are all essential because students inspire each other. This motivates learners to proactively seek a learning partner who can teach them a new skill.

> "There are some things that need to be practised, so they go and ask the other child, 'I want to do this with you.'" INT1

The observations show how learners chose their learning partners throughout the school day. In addition, the observation data revealed how learners supported each other in their learning, for example, by demonstrating how to do tasks or offering ideas on how to solve assignments. Furthermore, learners also helped each other with organizational matters related to their learning.

> "Two girls discuss what to do. One boy started counting a chain of 1,000 on his own, and the girls joined him." OP

Based on both the observation data and interviews, the maintenance of the Montessori classroom is the responsibility of the students. Tasks are divided among the students, rotating weekly. If someone forgets, the children themselves remind each other of their responsibilities, explains a teacher:

> "It's immediately clear that they have all taken on this responsibility, and if someone does not do what they are supposed to, a child will go and tell that child. I no longer must tell them." INT1

3.5 Teacher evaluation practices

The teacher evaluation practices applied in the observed Montessori classroom created a learning-supportive environment. The data analysis identified four subcategories: ongoing feedback during the school day, regular individual discussions with the learner about their learning, teachers guiding the learner to engage more deeply with chosen topics, and teacher's observation during the school day.

3.5.1 Ongoing feedback during the school day

The teachers provided learners with ongoing feedback throughout the school day, focusing on the learning process rather than just the outcome. For example, based on the observation data, the teachers emphasized the correctness of letters in writing tasks and acknowledged the child's effort. The teachers regularly checked if the learner was ready to continue with the task independently.

> "The teacher checks if the child remembers the fractions in order to continue with the worksheet. Based on the work completed by the student, the teacher understands that the child grasps the concept and can finish the worksheet independently." OP

In addition, based on the observation data, the teachers provided feedback at the learners' initiative. For example, the children asked the teacher to check how well they had completed their tasks. Examples from the observation protocol:

> "The boys go to a teacher to announce that they are done. The teacher agrees to come and check." OP

3.5.2 Regular individual discussions with the learner about their learning

As described in the subsections "self- and peer-assessment" and "instrumental support from the teacher and peers," we can also highlight the regular individual discussions between the teachers and the learner about their learning in the subsection on evaluation practices. Observations showed that one teacher held a brief 3–5-min individual discussion with each student daily to review completed tasks and future plans, making notes during the conversation. Teachers also conducted more in-depth 15–20-min discussions every two weeks to assess progress, ongoing work, and upcoming goals. During these longer meetings, the student's drawer of unfinished tasks and their learning portfolio of completed work were reviewed. Completed tasks were archived, and students set deadlines for unfinished ones, with agreements documented.

3.5.3 Teachers guided the learner to engage more deeply with selected topics

The evaluation practices of the observed Montessori teachers were characterized by belief in the students' abilities, as the teachers encouraged learners to engage more deeply with topics that interested them the most.

> "'I would like to, I enjoy prehistory,' says the child, who adds that they are making their own books on the topic." OP

In addition, the teachers noticed the learners' progress during the school day and offered opportunities to further expand their knowledge, for example, participation in the next presentation.

> "'I noticed that you did well with multiplication yesterday. What do you think about having a presentation next week on multiplication with larger numbers?' The child agrees." OP

Montessori teachers guided learners to engage more deeply with topics that interested them through goal setting. This was done by encouraging the learner to write new goals in their work diary and through one-on-one discussions. Example from the observation protocol:

> "'What else would you like to do?' asks the teacher. The child wants to conduct an experiment. The teacher notes it down and says, 'Next week, we'll do a STEM experiment.'" OP

3.5.4 Teacher's observation during the school day

Based on both the observation data and interviews, it can be said that Montessori classroom teachers observed the students' activities throughout the school day and made notes about each child's progress. The teachers mentioned in the interviews that they use both structured observations during lessons, where they measure, for example, a student's or a group's activity and work ethic throughout the school day, as well as ongoing observations of the student's general progress and characteristics, including mood and social interactions.

> "We have two types of observations. One of them is the activity sheets. These are provided to us from the training, where we can

> mark how active the child was during different parts of the day. We can also observe the entire group, noting when the group works better or worse at different times." INT2

The teachers explained in the interview that they note everything they observe about a child, such as which tasks they have chosen, how much time and effort they have dedicated to those tasks, who they worked with, and how the collaboration went.

> "Actually, we observe everything—whether the child is happy, if they enjoy being there, if something is bothering them, whether they have a conflict with someone, or if they are having an issue with a specific person." INT2

Based on the interviews, teachers also try to notice during the observations if a child has a particular interest or readiness to move forward with a topic more quickly and thoroughly.

> "One child asked about division. … I then made a note that they are interested in division. We always take notes and based on that, we plan the presentations." INT1

Montessori teachers used their observation notes during regular discussions with the learners, but in the interviews, the teachers emphasized that they avoid directing the learner's attention to mistakes. The learner should reach the causes of their mistakes independently, as the teacher mentioned in the interview.

> "We do not directly say that something is wrong, but instead, we might ask, for example, if they have written a word incorrectly in the plural. … so that they recall the rule themselves." INT2

4 Discussion

The aim of this qualitative case study was to identify the characteristics that support SRL in a Montessori classroom, based on descriptions provided by Montessori teachers and observations in a Montessori primary classroom. Our study revealed that all characteristics of a high-SRL classroom, as outlined by Perry et al. (2002), were evident in the Montessori setting (see Appendix 2 "High-SRL Classroom Categories and Their Representations in the Montessori Classroom"). Therefore, the Montessori pedagogy supports SRL by emphasizing autonomy, intrinsic motivation, and reflective learning – core elements aligned with leading SRL theories (Zimmerman, 2000; Winne, 2011). Our findings showed that students made independent choices regarding learning tasks, methods, and pacing, used diaries for planning and self-assessment, and discussed their learning with the teacher and peers. These practices align with the characteristics of self-regulated learning described by Perry et al. (2002) and Zimmerman (2000).

The most prominent of the high-SRL classroom characteristics observed in the Montessori classroom was the students' extensive opportunity to make choices in organizing their learning. This was expected, as one of the core principles of Montessori's pedagogy is to give children greater responsibility in their learning process (e.g., Lillard, 2017; Marshall, 2017). In the observed Montessori classroom, students were able to choose not only what and how to learn, but also the depth and pace of their learning, meaning they had significant control over their learning, which supports behavioral SRL strategies, where the learner can organize the learning environment and select learning materials (Sins et al., 2024). This approach to learning is indeed different from traditional general education and has yielded better results in SRL, as demonstrated in comparison studies conducted in both primary and secondary education (Ervin et al., 2010; Tiryaki et al., 2021).

However, it must be acknowledged, as confirmed by the results of our study, that the choices of students in the Montessori classroom are still limited. For example, the students' choices are limited by the prescribed learning materials, which are specific Montessori educational tools [Association Montessori Internationale (AMI), 2023]. Therefore, the child can choose a learning material, but only from the available set of materials. In addition, the findings of this study indicate that students are required to attend teacher-assigned presentations, which are selected based on teachers' observations of students' interests and skills, highlighting the importance of supporting students in areas where skill development is needed. While participation is mandatory, students can choose challenging tasks during work time between presentations. Although Lillard (2017) described the three-hour work cycle as uninterrupted independent learning, our findings indicate that in practice, it was not entirely uninterrupted due to these scheduled presentations.

Providing structured, age-appropriate choices – a core feature of SRL – can help sustain student autonomy in the Montessori classroom, even when the uninterrupted work cycle is occasionally guided by teacher-led presentations. This balance between freedom and structure is especially important for younger learners, whose self-regulatory capacities are still developing (Efklides, 2011). In the interviews, Montessori teachers emphasized the importance of gradually increasing student responsibility. They described how younger children initially require more support and structure, but as they mature and demonstrate readiness, teachers deliberately reduce their level of guidance. This approach aligns with previous research (e.g., Li et al., 2023), which highlights that adaptive scaffolding – adjusting teacher support based on learner readiness – effectively promotes the development of SRL.

Students' autonomy in the observed Montessori classroom was systematically supported by the teachers, as confirmed by previous research (Koh and Frick, 2010). Teachers, through their evaluation practices (Perry et al., 2020), were able to create a positive and supportive learning environment, which also supports students' SRL (Koh and Frick, 2010). For example, the observed Montessori classroom teachers did not draw public attention to the mistakes made by students, instead giving the child the opportunity to discover the mistakes on their own and learn from it, which supports learners' SRL (Perry et al., 2002, 2020). The teachers in the observed Montessori classroom used ongoing evaluation, focusing on the learning process and the individual development of the student, which also confirms the findings of previous studies (Whitescarver and Cossentino, 2008) and supports SRL (Perry et al., 2020).

In the observed Montessori classroom, students' knowledge and skills were not evaluated through common class tests or external evaluations. This method of evaluation, including tests and external evaluations, is not aligned with Montessori pedagogy, which focuses on continuous observation and intrinsic motivation rather than external evaluation [Association Montessori Internationale (AMI), 2023; Choi, 2024]. At the same time, the Montessori experience

confirms that students can be supported in their learning without external assessments, a practice that could be more widely adopted by other general education schools, where mandatory tests and exams are the standard assessment practices (OECD, 2023b). The study results from the Montessori classroom show that when students are given age-appropriate responsibility for their learning, there is no need to motivate them through external evaluation, as intrinsic motivation to learn develops within the student.

Despite this strong alignment with SRL theory, it is important to acknowledge potential challenges. The high degree of autonomy characteristic of Montessori education may not benefit all learners equally, particularly younger children whose executive functions – such as working memory, cognitive flexibility, and inhibitory control – are still developing. Research by Sosic-Vasic et al. (2015) shows that while autonomy-supportive environments are associated with stronger executive functioning and intrinsic motivation, students with lower executive capacities may depend more on externally regulated learning strategies. While the findings of our study indicated that Montessori teachers continuously monitor students' learning, wellbeing, collaboration, and general behavior throughout the day – making written notes about each child – it remains important to be attentive to how younger students, particularly those just beginning their school journey, manage the freedom offered in the Montessori environment. Some learners may benefit from additional structure and scaffolding at certain stages.

While the Montessori classroom observed in this study reflects strong alignment with high-SRL principles, it is important to consider how these features might be adapted for learners with differing cognitive or emotional self-regulation capacities. For example, the high degree of autonomy and expectation for self-monitoring may pose challenges for students with underdeveloped executive functions or neurodivergent learning profiles, who may depend more on externally regulated learning strategies (Sosic-Vasic et al., 2015). In such cases, additional scaffolding—such as more explicit instruction in metacognitive strategies, increased adult guidance, or modified pacing—may be necessary to ensure accessibility and support (Azuka et al., 2024).

Although standardized assessments were not used in the observed Montessori classroom, learning was continuously monitored through individualized observation, teacher notes, and student work diaries. Teachers tracked students' task selections, persistence, collaboration, and self-corrections throughout the day. Instructional adjustments were typically made during one-on-one teacher–student conferences, where both parties reflected on recent progress and documented next steps to support further learning. These formative and dialogic assessment practices enabled responsive teaching without reliance on formal testing. Such approaches align with Perry et al.'s (2002, 2020) conceptualization of SRL-supportive classrooms, in which assessment is embedded in ongoing classroom interactions and serves to guide learner autonomy rather than to judge performance. Furthermore, this type of process-based and dialogic feedback is consistent with Dignath and Veenman's (2021) emphasis on scaffolding and co-regulation, where teacher guidance fosters metacognitive engagement and self-reflective learning. Rather than relying on summative tests, these practices create opportunities for learners to monitor their progress and take greater ownership of their learning, reinforcing core elements of self-regulated learning (Zimmerman, 2000; Andrade, 2010). These findings highlight the potential of continuous, embedded assessment to inform instructional decisions in real time. Although standardized assessments are not used, teacher observation and dialogue provide valuable insights into student progress, enabling teachers to respond flexibly to individual needs. Even in more conventional school settings, integrating structured student–teacher conferences or self-assessment tools could complement standardized assessments and support a more responsive and learner-centered approach to teaching (Andrade, 2010).

Through regular completion of work diaries, where students planned and monitored their learning, and individual discussions about their learning with teachers, metacognition was also supported in the Montessori classroom, which is important for fostering SRL (Perry et al., 2020; Sins et al., 2024). Learners set goals, planned their learning, and analysed their results. In goal setting, the focus in the observed classroom was on subject-specific goals, with less emphasis on the development of general skills (e.g., communication skills, collaboration skills). In discussions between the teacher and the child, the focus was primarily on what the child had completed and their future plans, with less emphasis on guiding the child to analyse why something had succeeded or failed. The reason for this may lie in the fact that these were 1st to 3rd grade students, who are still learning to analyse their own learning. However, when learners practise goal setting and planning their learning in a supportive environment, they will be more prepared for in-depth self-reflection in the future (Perry et al., 2020).

The findings of our study can also be interpreted through the lens of Winne's (2011) cognitive model of SRL, which conceptualizes SRL as a cyclical process consisting of task definition, goal setting and planning, enacting learning strategies, and adaptation based on self-monitoring. In the observed Montessori classroom, students engaged in goal setting and planning through learning diaries, implemented learning strategies during work periods, and reflected on progress in one-on-one discussions with teachers. However, the final phase – adaptation – appeared to be less developed among younger students, which may reflect their still-maturing executive functioning skills. This highlights again the importance of balancing autonomy with developmentally appropriate structure, particularly in early primary education. While Montessori pedagogy strongly emphasizes independence, it also provides external scaffolds – such as prepared environments, structured routines, and presentations – that support students in managing their learning effectively. This combination of freedom and guidance embodies what Efklides (2011) has called the interplay between personal-level dispositions and task-level experiences, where learners' metacognitive and motivational regulation evolves through supported practice.

The learning environment also plays a crucial role in supporting SRL. A classroom atmosphere that minimizes competition, promotes continuous problem-solving, and encourages collaboration helps to foster SRL (Paris and Paris, 2001; Perry et al., 2020). In the Montessori classroom observed in this study, students worked towards their goals, often alongside their chosen peers, but without competing against one another. Teachers guided students to support and teach each other, a practice that students themselves initiated as well; this is also consistent with previous research (Dignath and Veenman, 2021; Perry et al., 2002). The ability to work in pairs or small groups, often self-organized, is a critical feature of the Montessori method that supports the development of SRL [Association Montessori Internationale (AMI), 2023]. At the same time, the teachers in the observed Montessori classroom also monitored how students collaborated with one another and directed them to work separately when necessary. On

one hand, this approach limits the students' choice of learning partners, but on the other hand, it can support learning if the formed group is unable to learn collaboratively. Stimulating collaborative learning, learning from and supporting peers, and seeking clear, comprehensive, and useful feedback also support behavioral SRL strategies (Sins et al., 2024).

Furthermore, the design of the Montessori environment – where students have control over their learning materials and workspace – reinforces SRL, a key feature identified in the SRL literature (Gentaz and Richard, 2022). Research indicates that the organization of the classroom is a significant factor in supporting SRL, with routines that provide external structure and guide student behavior (Perry et al., 2020). Another crucial element is the establishment of clear rules that support self-regulation skills (Savina, 2020). In the Montessori classroom observed in this study, for example, clear rules were followed by the children, which aligned with the overall structure of the environment. Teachers emphasized that students were expected to engage in meaningful work and to select challenging tasks. This structure was also reflected in the design of the learning materials and classroom layout, which, according to previous studies (Lillard, 2017), consistently supported students' ability to make autonomous choices.

4.1 Practical implications and adaptation to conventional classrooms

Although the present study focused on a Montessori context, the identified SRL-supportive practices have broader relevance and can be meaningfully adapted to conventional school settings. One key takeaway of our study is the value of offering students structured choices – such as letting them choose the order of completing tasks or select from differentiated materials – which supports autonomy without compromising curricular goals. Even within standard lesson blocks, providing short self-directed work periods or flexible grouping options can foster SRL.

The emphasis on peer collaboration observed in the Montessori classroom can also be adapted. Teachers in conventional classrooms can create routines for peer dialogue, co-planning, or joint reflection, particularly in project-based learning contexts. Mixed-ability groupings and student-led discussions can mirror the multi-age, peer-supported learning found in Montessori settings and encourage co-regulation strategies (Dignath and Veenman, 2021; Lillard, 2017; Perry and VandeKamp, 2000; Perry et al., 2002).

Additionally, the use of individual learning diaries and weekly planning tools can be introduced in non-Montessori schools to strengthen students' metacognitive awareness. These tools allow learners to set goals, monitor their progress, and reflect – regardless of the pedagogical approach. Importantly, opportunities for self-assessment and peer assessment can also be incorporated into conventional classrooms. These practices, which were systematically embedded in the observed Montessori classrooms, are not exclusive to that context. Conventional schools could benefit from adopting them more confidently and deliberately, especially as they require relatively modest structural changes but can significantly enhance students' autonomy and self-regulation. Enabling students to check and revise their own or a classmate's work not only promotes metacognitive engagement but may also help reduce teachers' workload. The time saved can be redirected toward providing instrumental support to students who need individual guidance.

For policymakers, the findings suggest that fostering SRL does not necessarily require structural overhauls but can begin with pedagogical adjustments. In particular, teacher autonomy should be protected and trusted. For example, assessment practices tend to be more tightly regulated. In Estonia, descriptive assessment is permitted up to grade 6; however, from grade 7 onwards, teachers are required to convert all evaluations into a five-point numerical scale. Providing teachers with greater autonomy in assessment – alongside targeted professional development in learning-supportive assessment practices – could promote the broader adoption of strategies that foster SRL.

4.2 Limitations and prospects of the study

This study provides valuable insights into how Montessori classrooms support SRL by identifying key characteristics that align with high-SRL classroom principles (Perry et al., 2002, 2020). By analysing classroom observations and teacher interviews, this study deepens the understanding of how SRL strategies are operationalized in the Montessori classroom, offering practical implications for educators seeking to implement SRL-friendly classroom settings.

Despite these contributions, the study has several limitations that must be acknowledged. First, the research was conducted in a single school with a small number of participants, which limits the generalizability of the findings. The observed school had implemented the Montessori approach only one and a half years prior to the study, and although both participating teachers held Montessori teaching qualifications, their prior experience in more conventional settings may have influenced how effectively Montessori principles were implemented in practice.

Second, the findings reflect the specific geographic and institutional context in which the study was conducted. The Estonian education system, where public funding allows for both national curriculum alignment and the implementation of alternative pedagogies such as Montessori, offers a unique educational climate that may differ substantially from systems elsewhere. School-specific practices, administrative culture, and national curriculum regulations likely shaped the implementation of SRL strategies and their interaction with Montessori pedagogy. To support transferability, the methodological section of the article includes a detailed description of the educational context in which the study was carried out.

Third, video recordings of classroom interactions were not permitted due to parental concerns and the desire to avoid disrupting the natural classroom environment. Although detailed field notes were taken by two observers, the lack of audiovisual data may have limited the depth of data, particularly regarding subtle teacher-student and peer interactions related to SRL. Furthermore, the possibility of an observer effect cannot be fully excluded, even though observers used a non-intrusive method and remained in the classroom for an extended period to minimize reactivity.

Future research should aim to replicate and expand these findings across more diverse educational contexts, including inclusive and special education classrooms. Comparative case studies and longitudinal designs across different pedagogical and policy settings could clarify how SRL-supportive strategies function and evolve. Mixed methods approaches that integrate qualitative insights with

learning outcomes or cognitive data would further strengthen understanding of how SRL can be effectively fostered for a broader range of learners.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Ethics Committee of University of Tartu. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin. Written informed consent was obtained from the minor(s)' legal guardian/next of kin for the publication of any potentially identifiable images or data included in this article.

Author contributions

LK: Conceptualization, Project administration, Methodology, Formal analysis, Writing – original draft, Data curation. LL: Writing – review & editing, Methodology, Investigation, Supervision. MP: Supervision, Conceptualization, Writing – review & editing. K-JL: Writing – review & editing, Investigation, Visualization.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2025.1594556/full#supplementary-material

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