Science Teaching in Extended Education: A Systematic Mapping

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Abstract: This study aims to map the purposes, content and teaching approaches of science teaching aimed at schoolchildren aged 6–12 years outside the regular school setting, as described in previous research. The findings are based on a systematic search in four databases and three journals, resulting in the selection of 51 articles based on specific inclusion criteria. These articles were analyzed thematically through content analysis based on the didactic questions of why, what, and how. The findings indicate that the mapped articles highlight several purposes, contents, and teaching approaches. The purposes involve increasing interest in science, developing students' ability to act in everyday life and society, increasing knowledge and skills, promoting careers in science or academic success, and reaching other aims not directly related to science. The teaching includes contents such as scientific phenomena and concepts, nature of science and scientific processes, and socio-scientific issues. The approaches of teaching vary from being mostly teacher-led, mostly student-led to being both teacher- and student-led.

Keywords: didactics, Extended Education, science, systematic mapping, teaching

Introduction

In this article, we explore the characteristics of science teaching in Extended Education as described in previous research literature. The systematic mapping focuses on answers to the didactic questions *why, what* and *how* and aims to increase knowledge of present Extended Education practices aimed at students aged 6–12 years.

Bae et al. (2019) noted that Extended Education, including afterschool science programs, is expanding globally and concluded that Extended Education worldwide is booming even when it comes to education focused on science. Extended Education is highlighted as an effective way to address the challenges faced by public schools, meet various social needs such as childcare and education for immigrants, and develop a skilled workforce in certain areas (Bae, 2019). In line with this, Ecarius et al. (2013) state that in most countries "not only educational policy arguments but also questions of the employment market and family policy play an essential role in the justification of out-of-school programs and activities" (p 8).

Extended Education has recently garnered increased attention in research. International studies on Extended Education have explored various topics, including the effects of different activities on students' academic performances, social and emotional abilities, equity, health and well-being as well as broader societal impacts have been investigated (Ecarius et al., 2013; Skolforskningsinstitutet, 2021). As reported in a recent research review (Skolforskningsin-

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stitutet, 2021), Extended Education research in the Nordic context has primarily focused on organizational changes within after-school programs, the integration between after-school programs and schools, and the professional role of after-school educators. At the same time, there is growing interest in the content of after-school programs and their significance for students' development and learning.

Research focusing on science teaching within the context of Extended Education remains limited. There are a few research reviews on science teaching in Extended Education focusing for example gifted students (Chowdhury, 2018), equitable participation (Heath et al., 2022) and science education in museums and science centers (Ennes & Lee, 2021). However, to our knowledge, there is no previous mapping of the characteristics of science teaching in Extended Education, focusing on teaching purposes (why), content (what), and teaching approaches (how). Such a mapping has the potential to meet the needs of teachers who struggle with how to teach science in Extending Education settings and to make an important contribution to research by addressing a currently underexplored area.

Providing teachers with a systematic overview of different teaching purposes, content and approaches is a way to support teachers in seeing alternatives for their teaching. Thus, such an overview has the potential to support teachers' didactic analysis (Klafki, 1995) and the didactic positions and choices teachers make. Contributing to this kind of support is a central task of the didactic research tradition (Wickman, 2014). The mapping of the characteristics of science teaching in Extended Education settings presented in this article can be seen as a step toward developing didactic models (Wickman, 2014) for teaching science in Extended Education. Such modelling takes a starting point in extracting knowledge, practices and experiences from teachers and actual teaching settings.

A significant portion of the research on science teaching in Extended Education focuses on Extended Education aimed at secondary students. In this study, descriptions of the characteristics of science teaching aimed at students aged 6–12 in Extended Education contexts are extracted from peer-reviewed, international research literature and systematized. The results are structured as different answers to the didactic questions why, what and how.

Aim and Research Question

The study aims to increase knowledge of the characteristics of science teaching in Extended Education as described in previous research literature.

The following question is the starting point for the systematic empirical mapping:

What characteristics regarding science teaching in Extended Education, concerning purposes, contents and teaching approaches, can be extracted from descriptions in previous peer-reviewed research articles?

Method

The literature search on the purposes, content and teaching approaches of science education in different Extended Education contexts was conducted systematically in one national database (Swedish), three international databases and three journals. The databases used in the search were the *International Web of Science*, *Education Research Complete* (ERC), *Education Resources Information Center* (ERIC) and Swedish *SwePub.* Supplementary literature searches in journals were made in the journals: *International Journal for Research on Extended Education*, *Science Education*, and *International Journal of Science Education.*

The following keywords were used to search for different types of Extended Education: *Extended Education, Educare center, After school program, Leisure time center, Leisure education, Leisure time, Extended school, Science club.* Combined with these keywords, the following concepts for science were used: Science*, STEM[1], Physics, Chemistry, Biology and Scientific Literacy to track articles on science teaching in Extended Education. Given that a substantial portion of Extended Education activities concerns students aged over 13, and this article focuses on students under the age of 13, a restriction was added to exclude research conducted in secondary school, adult education, or high school. The search was limited to peer-reviewed articles, hits from the last ten years (2013–2023), and articles written in English or Nordic languages (Danish, Norwegian, Swedish).

The literature search resulted in a total of 1430 unique hits. A relevance review was then made in two steps (see Figure 1 below). In the first step, a relevance review was carried out by title and abstract. In the second step, a review and quality assessment were made in full-text reading. Specific inclusion and exclusion criteria were used (Table 1). The final sample consisted of 51 articles. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement (PRISMA) flow chart was used to compile the searches and the inclusion/exclusion process transparently (Moher et al., 2009).

1 STEM is an umbrella term and encompasses Science, Technology, Engineering and Mathematics.

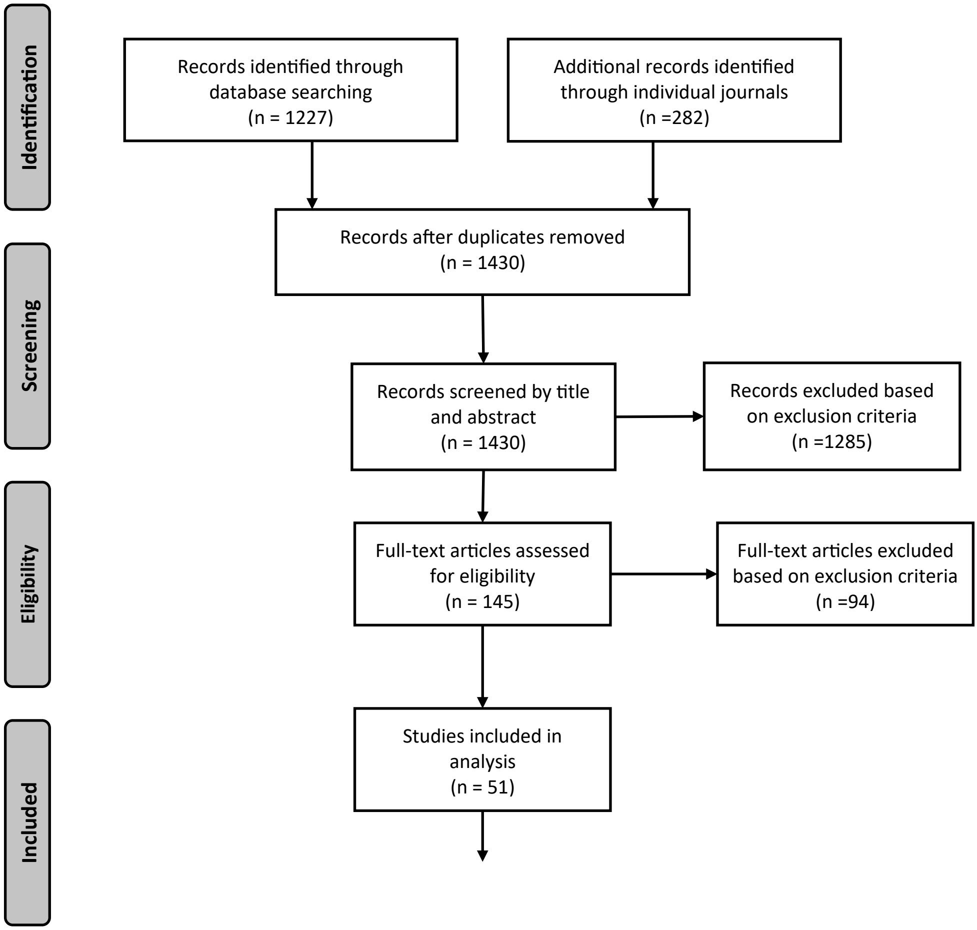

Figure 1. *Flowchart of Relevance Review (Moher et al., 2009).*

Inclusion and Exclusion Criteria and Quality Requirements

The search targeted descriptions of science teaching in Extended Education settings as presented in academic, peer-reviewed research articles. Articles describing the purposes, content, and/or teaching approaches in science teaching, and where teaching is carried out, were included. Studies that did not describe teaching were excluded. We chose to exclude studies focusing on pre-service teachers' development because our focus has been on teaching aimed at students. Regarding the types of teaching contexts included in our studies, we have based the inclusion/exclusion criteria on a conceptual framework by Bae (2019), which classifies learning opportunities that students may have by time and space (see Figure 2). In this study, we have limited focus towards studies included in areas 2 and 3, since they are located outside regular school hours, which is the kind of Extended Education that is our focus.

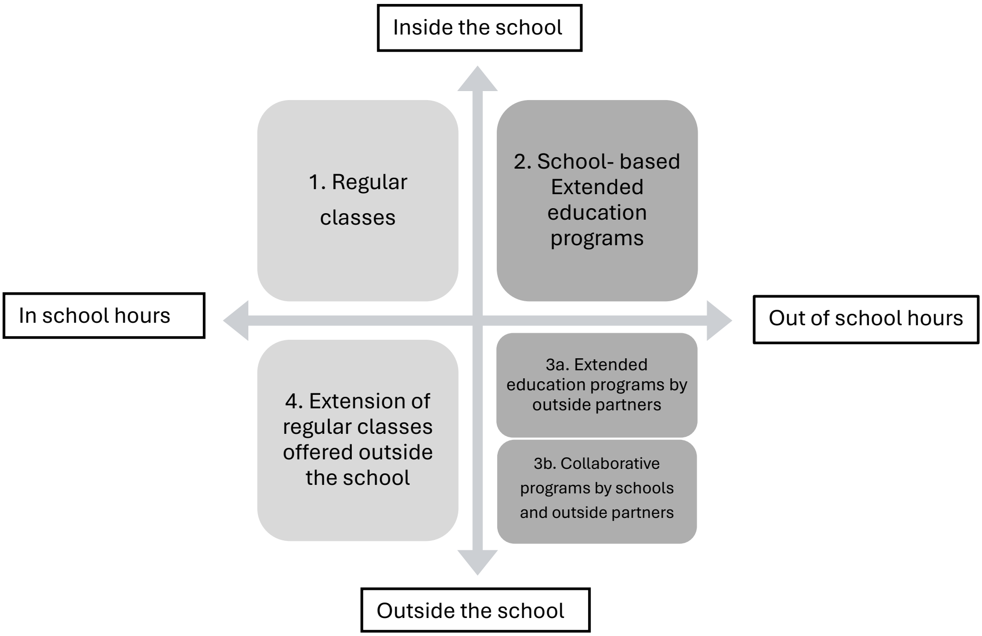

Figure 2. *Scope and Field of Extended Education Adapted from Bae (2019).*

Regarding quality criteria, we have, in addition to the requirement of peer review, chosen to exclude articles written in journals targeting practicing teachers, i. e., we have only included scientific articles intended for the research community. In the full-text reading of the articles, we have discussed the quality of the various articles together. The inclusion and exclusion criteria are summarized in Table 1.

Table 1. Inclusion and Exclusion Criteria

	Include	Exclude
Type of study	Empirical studies Peer review journals, scientific journals	Articles aimed at teachers Articles that are not peer-reviewed
Participants	Students aged 6–12 years Teachers in Extended Education or equivalent staff	Studies that predominantly involve students not aged 6–12 years. Studies focusing on student teachers' development
Context	Bae's area 2,3	Bae's area 1,4
Content	Articles in which purposes, content, and/or teaching approaches of science teaching are described	Studies focusing on teacher professional development

Include	Exclude
	Studies focusing on teaching content related to mathematics and technology or other non-science subjects
	Studies concerning other types of leisure activities such as culture or sport
	Studies that do not describe teaching

The Included Articles

The articles included were conducted in different countries. Most of the articles (42) were conducted in the United States. The remaining articles originate from various parts of the world: Australia, Canada, Germany, Greece, Singapore, Taiwan, and Turkey.

In terms of Bae's (2019) framework on different types of activities, 29 of the included articles consist of activities within area 2, i. e. school-based extended programs. 9 articles consist of activities within area 3a, i. e. programs by outside partners, and 13 articles consist of activities within area 3b, performed in collaboration between schools and outside partners.

There is variation in the age of students included in the studies. Some studies are only about a single age group, while other studies concern students of different ages, with most students aged 6 to 12.

A summary table of the 51 included articles is attached (Appendix A).

Analysis

A qualitative content analysis inspired by Graneheim and Lundman (2004) has been carried out on the 51 articles, based on the following analytical questions:

- *Why*- what purposes emerge in the teaching?
- *What*- what content is taught?
- *How*- how are teaching approaches conducted in practice?

The emphasis has been placed on the descriptions of science teaching in the articles, rather than on research questions and results of the studies. When reading the articles, descriptions of the teaching regarding the various didactic questions (why, what, how) have been highlighted in three different colours (see example in Figure 3). For each of the three didactic questions, a content analysis was made, where preliminary categories were created describing different answers to the didactic question. The preliminary categories were revised and cross-checked upon further reading of the material until the categories were stable and agreement between all authors was reached. In the example in Figure 3, the purposes—answers to the why- question described in the text—were highlighted in Dark grey and categorized as *Increase knowledge and skills.* The content of the teaching was highlighted in Grey and categorized as *Scientific phenomena and concepts.* Light grey highlights indicated elements in the text connected to teaching approaches, exemplifying the category *Both teacher- and student-led teaching.*

Intervention: After-School Program

The Center for Educational Outreach at Baylor College of Medicine developed and disseminated the curriculum for the after-school intervention with support from the National Institute of Allergy and Infectious Diseases (National Institutes of Health). The curriculum consisted of 13 inquiry-based activities designed to increase students' knowledge of microorganisms, the spread of disease and general scientific vocabulary, and also to enhance science skills in areas such as data collection and graphing. The development team designed each activity or lesson to fit within a 45-minute time period and to be appropriate for after-school settings. Setup for teachers was minimal, and students were not required to complete worksheets or other activities that resembled homework. Instead, students worked actively in cooperative groups to solve a problem or question. For example, early in the semester, students explored the question, "What causes magnification?" by observing objects in a clear glass of water (objects looked larger when viewed through the curved sides of the glass), using hand magnifiers to observe pennies, and making their own magnifiers from strips of clear plastic and drops of water.

Figure 3. *Examples of How Parts of the Descriptions of Teaching in the Articles Were Highlighted Based on the Three Didactic Questions. The Example Is Taken from Article No. 2.*

In the result section, the central aspects of the categories are presented and sorted under the three didactic questions – why, what and how.

Result

The following section presents the results of the mapping divided into the three different didactic questions why, what, and how. Examples illustrating the categories are referenced with the number corresponding to the article in the attached table (see Appendix A).

WHY- What Purposes Emerge in the Studied Teaching?
From the analysis, five categories of purposes were developed, which are presented and described below.

- *Increase interest in science*
- *Develop students' ability to act in everyday life and society*
- *Increase knowledge and skills*
- *Promote science careers or academic success*
- *Science education to reach other aims not directly related to science*

One of the purposes is described in the category *Increase interest in science.* The purpose highlighted is that the teaching of science in Extended Education should increase students' interest and motivation, stimulate their curiosity in science, foster positive attitudes towards science and promote the development of positive science identities. For example, in article no. 17, connections between teaching content and the students' lived experiences were made to increase the students′ interest, and in article no. 20, challenges related to real-world problems in pediatric cancer research were used in the teaching to increase students' science identities and critical thinking skills.

The category *Develop students' ability to act in everyday life and society* contains teaching purposes related to enhancing students' agency in their daily lives and promoting active participation in society, as well as the fostering of specific behaviors. An example of the former is the teaching described in article no. 25, where students acted to save a local toxic lake. However, in other teaching descriptions, rather than emphasizing the development of students' agency, teaching purposes are related to the fostering of desirable behaviors in students when it comes to nature and the environment. In article no. 44, the purpose of the teaching was to influence students' behavior in a specific direction, in this case to influence future "conservation behavior" (p. 685).

Another category of purposes is *Increase knowledge and skills.* It means that teaching aims to increase students' knowledge of the products of science, the nature of science or skills related to scientific practices. Considering scientific products, some articles describe that the teaching purpose is to develop knowledge of science in general, while other articles describe teaching focusing on more specific knowledge that the students should develop, for example, knowledge of the environment, animals and nature, matter, electricity or force and motion. In article no. 27, for example, a video game was used to enable students to make sense of materials "as emergent" (p. 40) from their molecular structure. Other articles describe teaching aimed at increasing students' knowledge of the nature of science (for example article no. 49). Considering scientific skills, some programs focus on improving students' skills related to specific steps in science processes, such as data collection and graphing or making hypotheses and drawing conclusions. In other cases, the teaching includes improving students' skills throughout a whole research process, like in article no. 30.

The category *Increase science careers or academic success* describes the purpose to strengthen and improve students′ academic performance and results, both individual results and national results, bridge science in school with science in Extended Education and promote further education and careers related to science, which are also purposes that appear in the articles. An example of an article in this category is no. 21, where teaching in a science club includes guest speaker visits from local institutions and STEM-based organizations to build community connections and introduce students to STEM-related career opportunities.

The last category of purposes is *Science education to reach other aims not directly related to science* and includes teaching aiming at developing abilities and knowledge, such as language development, or the development of cognitive and social abilities, where science is used as a means. There are also examples of teaching science with purposes concerned with increasing physical activity, increasing parental involvement or creating a connection to nature. One example is the teaching described in article no.11, where bilingual Latino students formulated questions, sought answers, and presented their results. The purpose of the teaching was to develop students' language.

Articles often express that teaching in Extended Education has a goal of targeting various underrepresented groups, such as socio-economic disadvantaged groups, different cultural groups or girls, to contribute to social justice. However, since targeting specific under-represented groups with Extended Education is something that is determined in advance, it is omitted here as an individual category. It does not focus on didactic purposes that the teacher him/herself handles. In addition, it overlaps with the categories described above.

WHAT- What Content is Taught?

The content of the teaching presented in the different articles is varied. Three different categories of content have emerged in the analysis:

- *Scientific phenomena and concepts*
- *Nature of science and scientific processes*
- *Socio-scientific issues*

The first category of content is *Scientific phenomena and concepts.* There is content that addresses various science phenomena which relate to the traditional science disciplines of physics (e.g. energy and electricity), chemistry (e.g. matter and chemical processes) and biology (e.g. plants and animals). In article no.1, the students learned about energy issues and alternative energy while creating 3D solar-powered cars. In other articles, the content of the teaching is interdisciplinary, such as water or space. One example of the latter is the teaching described in article no. 38 where after-school programs and summer camps had a focus on water quality and the students had the opportunity to learn about the water cycle, the chemical properties of water, water and life, hydration and the human body, formation of water sources and water conservation.

In the descriptions of science teaching in the articles, the teaching of scientific concepts that are directly linked to specific phenomena and models is highlighted, as well as the relationship between different concepts. One example is the teaching described in article no. 35, where the activities introduced students to different concepts relevant to space travel, including the Earth, the solar system, microgravity, and how people live in space during space travel.

The second category of content is connected to the *Nature of science and scientific processes.* This category describes teaching which focuses on scientific processes such as asking questions, planning and conducting investigations, scientific argumentation and concluding. For example, article no. 3 describes teaching where students were asked to look and observe the swing pattern from a hanging clock and figure out possible factors influencing its behavior. The students considered their research questions, hypotheses, and made observations during the experiment, and finally drew an evidence-based conclusion.

The category also encompasses the nature of science perspectives, for example, who scientists can be and what characterizes them (e. g. article no. 12) and what they can work with (e. g. article no. 5).

The third category of content is *Socio-scientific issues.* The teaching content addresses issues such as solving real-world problems, different challenges in society and environmental and sustainability issues. One example is in article no. 28, where students learned about petroleum usage and the conservation of energy within a scenario where solar power could potentially lessen reliance on petroleum.

HOW- How are Teaching Approaches Conducted in Practice?

The articles provide examples of concrete teaching activities. Common activities include the use of digital technology (e. g. for information, documentation and presentation), experiments, observations, and hands-on lab work (such as testing liquids, conductors and insulators, as well as solving problems through making prototypes like solar cell cars or wind turbines). Students also engage in reading, writing, and watching videos related to science. Some activities involve meeting real researchers, exploring STEM institutions, and discussing in groups.

When it comes to teaching approaches, the mapping shows differences concerned with how the teaching is guided and structured, along with the roles of students and teachers. Based on the analysis of teaching approaches, three categories have been developed linked to the teaching approaches:

- *Teacher-led teaching*
- *Student-led teaching*
- *Both teacher- and student-led teaching*

In the category of *Teacher-led teaching*, it is teaching that is planned and structured by teachers. Sometimes it is clear that the teaching follows a specific curriculum and that it can be the same arrangement for several different schools. In this category, teachers provide instructions, lead activities, and guide discussions. The students take part in the teaching and participate actively in it. An example is in article no. 16, where a specific program forms the basis for teaching. Within the program, 11 central structural components are adapted to the curriculum taught by public schools during regular school hours. This curriculum continues in an after-school program and a summer program. For example, lessons on birdlife as well as on cell biology in school are strengthened by activities led by the teacher in the after-school program.

The category *Student-led teaching* is about the students largely having control over the teaching as they are given the freedom to choose the subject/problem and to explore and develop ideas based on what they are interested in. They are usually active in everything from planning to execution. The teachers in this category mostly act as supportive guides. They sometimes provide some instruction on concepts, and/or help with structure, provide materials, and provide feedback. For example, in article no. 7, activities were created based on the students' interests. The students presented their ideas or questions on Post-it notes to determine the next week's activity. Any ideas or questions were saved for future planning sessions by the students. The adults encouraged them to generate questions and guided their explorations, and they assisted in providing materials when students asked for them.

The third category *Both teacher- and student-led teaching* means that the teachers have a central role in planning, structuring and leading activities as well as introducing concepts and materials. They adapt the planning of activities, often based on the students' interests and needs and provide guidance, instructions and feedback. Initially, their role is often more controlling and instructing, but they become more guiding and supportive over time. The students play an active and central role in the learning process by participating in activities, experiments and projects. They can explore, formulate questions, plan and conduct their own experiments and design solutions to problems. In article no. 18, for example, the teaching was divided into eight modules where the control gradually shifted from the teachers to the students. Modules 1, 2, and 3 were conducted at a structured inquiry level. The questions here were presented by the teacher, the procedure was prescribed by the teacher, and the analysis procedure was directed and prescribed by the teacher. The students' role was to interpret results and draw conclusions. Modules 4, 5, 6, and 7 were at a guided inquiry level, which means that the questions were usually presented by teachers, the procedure was usually designed or selected by students, and the analysis procedure was usually guided by teachers, but students interpreted. The final module 8 was at an open inquiry level. Here, the questions were posed by students, the procedure of the inquiry was designed by students, and the analysis procedure was student-led.

Conclusion and discussion

In this article, we have provided a comprehensive overview of what characterizes science teaching in Extended Education as described in peer-reviewed research articles. It addresses an existing gap in comprehensive mappings of existing teaching practices. This mapping is based on systematic searches in databases and journals. Descriptions of science teaching in the selected articles were analyzed in terms of purposes, content and teaching approaches. The analysis reveals a range of diverse responses to the questions why, what, and how, highlighting diverse purposes, content and teaching approaches, see Figure 4. Thus, the systematic mapping increases knowledge and accessibility of the characteristics of science teaching in Extended Education. Such mapping serves as a valuable resource for teachers, teacher educators, policymakers, and researchers.

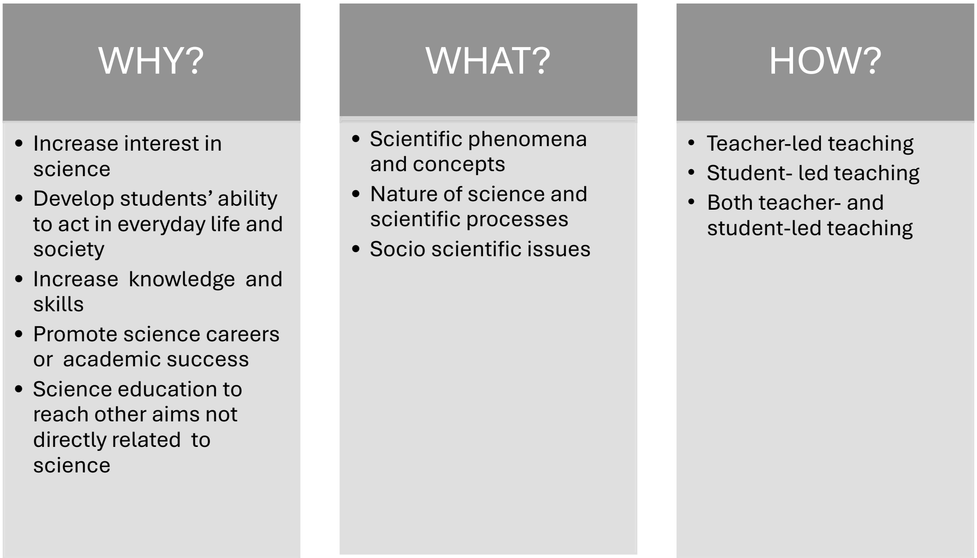

Figure 4. *Systematization of Characteristics of Science Teaching in Extended Education in Terms of Teaching Purposes, Teaching Content and Teaching Approaches.*

The systematic mapping explicitly highlights the characteristics of science teaching in Extended Education and sheds light on the diversity of intended purposes, teaching content and teaching approaches. As such, it serves as a tool for critically analyzing and developing teaching practices for science teaching in Extended Education settings. Teachers can use this mapping as a foundation for professional development in science teaching across various Extended Education contexts. It prompts reflection on key questions such as: *What purposes, content and teaching approaches characterize our teaching today? What aspects do we wish to develop or change?* Thus, the framework presented in this article has the potential to support didactic analysis, reflection and standpoints. Additionally, it contributes to the development of didactic models since it extracts present characteristics of science teaching in Extended Education as described in the research literature.

There are both strengths and limitations associated with mapping teaching practices based on the descriptions in research articles. One strength lies in our focus on describing teaching practices implemented in authentic Extended Education contexts, providing insights into how teaching is actually conducted. However, a limitation of extracting descriptions of teaching from research articles is that such articles tend to summarize results and research processes, which may result in a lack of detailed nuances regarding how teaching is conducted in the classroom. Therefore, it is important for research not only to rely on such descriptions but also to, in other studies, extract teaching purposes, content and teaching approaches from other sources to get a more nuanced and complete picture. This could include interviewing teachers about their experiences and perspectives (see Fransson et al., 2025) or observing teaching in practice (see Fransson et al., submitted). An additional advantage of using descriptions from research articles as data is that they offer access to many descriptions from diverse contexts. However, another limitation is that the study only includes articles written in English or

Scandinavian languages (Danish, Norwegian, Swedish), which may have led to the exclusion of relevant research published in other languages.

The map presented in this article highlights a diversity of approaches that can be valuable for teachers struggling with what should characterize science teaching in their contexts. However, we acknowledge that our mapping does not cover all aspects of teaching, such as how well goals are achieved or how teaching functions in various contexts. Our contribution lies in presenting a range of responses to the didactic questions which has the potential to serve as inspiration and support for teachers in identifying various possibilities and options for their teaching.

It is also important to emphasize that while we outline specific teaching options, this does not imply that they represent the only possible characteristics, nor that all alternatives described in the map are necessarily desirable. Other purposes, contents, and approaches may also be relevant and desirable depending on the context and the intended learning outcomes. Teachers, teacher educators, researchers, and policymakers must decide what they desire and prioritize for Extended Education in their specific contexts. In this process, the map outlining what characterizes science teaching in Extended Education presented in this article can serve as a valuable tool in analyzing and reflecting on current teaching practices and desired areas of further development.

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Appendix A

Table of the included articles

No	Article
1.	Hsu, P. S., Lee, E. M., Smith, T. J., & Kraft, C. (2020). Exploring youths' attitudes toward science in a Makerspace-infused after-school program. *Interactive Learning Environments*, 1 – 15.
2.	Newell, A. D., Zientek, L. R., Tharp, B. Z., Vogt, G. L., & Moreno, N. P. (2015). Students' attitudes toward science as predictors of gains on student content knowledge: Benefits of an after-school program. *School science and mathematics*, *115*(5), 216 – 225.
3.	Chen, H. T., Wang, H. H., Lin, H. S., P. Lawrenz, F., & Hong, Z. R. (2014). Longitudinal study of an after-school, inquiry-based science intervention on low-achieving children's affective perceptions of learning science. *International Journal of Science Education*, *36*(13), 2133 – 2156.
4.	Garner, P. W., Gabitova, N., Gupta, A., & Wood, T. (2018). Innovations in science education: infusing social emotional principles into early STEM learning. *Cultural Studies of Science Education*, *13*, 889 – 903.
5.	Hsu, P. S., Lee, E. M., & Smith, T. J. (2022). Exploring the Influence of Equity-Oriented Pedagogy on Non-Dominant Youths' Attitudes Toward Science Through Making. *RMLE Online*, *45*(8), 1 – 16.
6.	Hsu, P. S., Lee, E. M., Ginting, S., Smith, T. J., & Kraft, C. (2019). A case study exploring non-dominant youths' attitudes toward science through making and scientific argumentation. *International Journal of Science and Mathematics Education*, *17*, 185 – 207.
7.	Lindeman, C. (2020). Informal STEM Learning: Cultivating Curiosity. *The International Journal of Science, Mathematics and Technology Learning*, *27*(2), 25.
8.	Martínez-Álvarez, P. (2019). What counts as science? Expansive learning actions for teaching and learning science with bilingual children. *Cultural studies of science education*, *14*(4), 799 – 837.
9.	Patchen, A. K., Zhang, L., & Barnett, M. (2017). Growing plants and scientists: Fostering positive attitudes toward science among all participants in an afterschool hydroponics program. *Journal of Science Education and Technology*, *26*, 279 – 294.

No	Article
10.	Won, S. G., Evans, M. A., & Huang, L. (2017). Engagement and knowledge building in an afterschool STEM Club: analyzing youth and facilitator posting behavior on a social networking site. *Learning, Media and Technology*, *42*(3), 331 – 356.
11.	Arreguín-Anderson, M. G. (2015). Bilingual Latino Students Learn Science for Fun While Developing Language and Cognition: Biophilia at a La Clase M├ ígica Site. *Global Education Review*, *2*(2).
12.	Ayers, K. A., Wade-Jaimes, K., Wang, L., Pennella, R. A., & Pounds, S. B. (2020). The St. Jude STEM clubs: An afterschool STEM club for upper elementary school students in Memphis, TN. *Journal of STEM outreach*, *3*(1).
13.	Baran, E., Canbazoglu Bilici, S., Mesutoglu, C., & Ocak, C. (2019). The impact of an out-of-school STEM education program on students' attitudes toward STEM and STEM careers. *School Science and Mathematics*, *119*(4), 223 – 235.
14.	Barton, A. C., Tan, E., & Greenberg, D. (2017). The makerspace movement: Sites of possibilities for equitable opportunities to engage underrepresented youth in STEM. *Teachers College Record*, *119*(6), 1 – 44.
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