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METHODOLOGY FOR THE APPLICATION OF STEAM IN LIBRARIES

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1. INTRODUCTION

Modern libraries are changing rapidly: from traditional places where information is stored and disseminated, they are becoming vibrant spaces for culture, learning, and community. Technological advances and changing visitor needs are encouraging libraries to seek new ways of operating. One of these is STEAM education, which combines science, technology, engineering, arts, and mathematics. This direction is relevant to libraries for three reasons: digitization, the need for new skills, and the changing role of libraries.

Digital changes have affected how people learn, work, and create. Libraries actively contribute to the digital literacy of society, so they naturally incorporate new technologies into their activities, from robotics and 3D printing to virtual reality and artificial intelligence. STEAM activities not only introduce the community to these technologies, but also help them to try them out in a practical, curious, and safe way. Visitors can program, create prototypes, or explore data in an informal environment, without the pressure of evaluation.

Today, problem-solving, critical thinking, creativity, and collaboration skills are becoming increasingly important. STEAM education helps develop these competencies through playful, experiential methods. Libraries are becoming places where people of all ages, from children to seniors, can learn new things, experiment, discover hobbies, or try out creative ideas.

In addition, libraries are increasingly functioning as community centre creative workshops, and innovation spaces. The STEAM methodology fits perfectly with this new role of libraries: it encourages creativity, exploration, and interdisciplinary learning, strengthens community ties, and contributes to social inclusion. In this way, libraries become an important part of the educational ecosystem, where lifelong learning is possible.

The aim of these recommendations is to provide library staff with clear, relevant, and practical information about the STEAM educational philosophy, its implementation, and its potential in library activities. The publication aims to help librarians better understand the value of the STEAM methodology, ways of applying it, and effective practices for creating high-quality, engaging, and innovative activities.

Objectives:

1. To present the origins, development, and contemporary concept of STEAM education.
2. To outline the main principles of the STEAM methodology and their significance for libraries.
3. To discuss how libraries can become full-fledged STEAM centers in the community.
4. Provide strategies and practical advice for developing STEAM activities in libraries.
5. Review aspects of inclusion, accessibility, and sustainability in STEAM activities.
6. To offer methodological tools, templates, and practical tools for librarians.

These recommendations are intended for library professionals, cultural workers, education partners, and anyone seeking to integrate modern, creative, and comprehensive STEAM education methodology into library activities. This is a practical guide to help plan and organize STEAM activities, strengthen community engagement, and develop the potential of libraries as modern, future-oriented learning spaces.

2. THE PHILOSOPHY OF STEAM EDUCATION

2.1. The origins and development of STEAM education: from STEM to STEAM

The origins of STEAM are linked to the STEM education model, which was developed in response to modern society's need to foster strong competencies in natural sciences and technology. STEM (Science, Technology, Engineering, Mathematics) was based on the integration of four disciplines, focused on scientific and technological literacy and the ability to apply scientific knowledge in practice. As noted by Vaitekaitis (2023), the development of STEM was driven by the growing demand in the labor market for specialists capable of managing technological processes, implementing engineering solutions, and analyzing data.

However, over time, it became clear that technical skills alone cannot guarantee creative and socially relevant innovations. This insight prompted the addition of an arts component to the STEM model, giving rise to STEAM, which broadens the focus of education to include creative thinking, aesthetic expression, and cultural sensitivity. Girdzijauskienė and Šmitienė (2020) emphasize that the letter "A" in the model is not decorative—the inclusion of the arts has fundamentally reoriented the philosophy of education toward broader human cognition and idea generation processes.

The development of STEAM in international practice has been linked to the transition to experiential, project-based, and inquiry-based learning. This direction allows learners not only to understand scientific phenomena, but also to create new solutions by applying creative and technological synthesis. In Lithuania, the establishment of STEAM ideas went hand in hand with the creation of STEM centers, the training of teachers, and the strengthening of the legal and methodological basis. As shown by the research of Kulevičienė et al. (2023) and Kazancevienė (2025), this transition has brought both opportunities and challenges – from increased motivation for students to the need to improve teacher competencies and adapt infrastructure.

In summary, it can be said that STEAM emerged by adding an arts dimension to STEM, which enhances creativity and a humanistic approach. This model promotes not only analytical but also creative skills, making it particularly important for modern learning. STEAM opens up opportunities for libraries to create experiential, engaging, and innovative activities that combine technology with creativity and exploration.

2.2. The concept of STEAM education

The concept of STEAM education is based on the understanding that learning is a complex process in which knowledge of science, technology, engineering, arts, and mathematics comes together in a unified experiential whole. Girdzijauskienė and Šmitienė (2020) emphasize that the essence of STEAM is holistic learning, in which the arts act as a medium for creativity, imagination, aesthetic perception, and idea generation. This gives the educational process emotional and cultural depth, allowing learners to create meaningful interpretations and solutions.

The concept of STEAM emphasizes the active role of the learner—participants not only acquire knowledge, but also create, model, experiment, analyze, and reflect. In this way, education is close to the constructivist approach, according to which knowledge is constructed through experience and action. Kazancevienė (2025) notes that in early education, STEAM helps to maintain children's natural curiosity and need to explore, while in primary school, as shown by Matijošiūtė's (2021) research, combining arts and technology encourages students to solve problems creatively and actively participate in activities.

An important part of the STEAM concept is interdisciplinarity. This means that disciplines are not taught in isolation, but are linked to each other through real-life topics and practical situations. Kulevičienė et al. (2023) reveal that such education helps students better understand the complexity of the world, develops their ability to collaborate and apply knowledge in various contexts. Vaitekaitis

(2023) emphasizes that the STEAM philosophy shapes a broader understanding of the role of humans as creators—the ability to combine logic with creativity and technology.

Thus, the concept of STEAM education in Lithuania is being developed as an integrated learning model that combines creativity and experience, in which science, technology, engineering, arts, and mathematics are not separate disciplines, but interrelated elements that help to create a holistic educational process.

STEAM education is an integrated learning model that combines creativity and experience, in which science, technology, engineering, arts, and mathematics are not separate disciplines, but interrelated elements that help create a holistic educational process.

2.3. Key principles of STEAM education and their application in libraries

The STEAM education philosophy is based on principles that help create a learning environment that encourages complex thinking, creativity, independent exploration, and active participant involvement. These principles are universal to various educational environments, but in libraries they take on a unique form—here, learning takes place informally, playfully, without the stress of evaluation, and involving different community groups. When properly applied, these STEAM principles create conditions for learning for all visitors, including those with special needs.

2.3.1. Interdisciplinarity

The essence of STEAM is combining different disciplines into a single whole. Instead of the traditional division of knowledge into separate topics, attention is focused on real problems and phenomena that require elements of science, technology, engineering, arts, and mathematics to understand and solve.

Research by Kulevičienė et al. (2023) shows that this type of learning develops the ability to see interrelationships and apply knowledge in practice.

In libraries, interdisciplinarity is implemented through:

• thematic education, in which a book becomes an idea for experiments or creativity (e.g., the fairy tale "Alice in Wonderland" is linked to the study of mirror reflections);

• activities that combine literature, art, and technology (e.g., creating digital stories);

• a combination of exhibitions and creative workshops, where visitors explore a theme in different ways.

Interdisciplinarity gives participants with special needs more choice—they can participate through their strengths: sensory, visual, movement, sound, or practical activities.

2.3.2. Creativity

Creativity in STEAM education is understood broadly—it is not only artistic activity, but also the ability to find new solutions, create prototypes, and model. The integration of the arts helps to develop learners' imagination, emotional expression, aesthetic thinking, idea generation skills, and design thinking abilities (Girdzijauskienė & Šmitienė, 2020).

The creativity of participants in STEAM activities in libraries is revealed through:

• creative workshops (e.g., illustration, animation, electronics, 3D creation, music creation);

• design thinking tasks, where participants create ideas, sketches, and prototypes;

• activities that combine imagination with technology (light installations, comic book creation with AI tools).

Creative activities are particularly beneficial for visitors with special needs, as they allow them to express their thoughts in non-verbal ways and provide more successful experiences.

2.3.3. Research

Inquiry-based learning is the foundation of STEAM activities. It involves observation, asking questions, formulating hypotheses, experimenting, and reflecting on results. Kazancevienė (2025) emphasizes that inquiry is particularly suitable for early education because it supports children's natural curiosity.

In libraries, inquiry can be organized through:

• mini-experiments and practical tests;

• sensory activities for young children (e.g., water, colors, sounds);

• thematic searches in the library (e.g., "scientific discovery routes," "search, explore, discover");

• outdoor exploration combined with book recommendations.

For participants with special needs, exploration provides a safe structure, many sensory experiences, and the opportunity to learn through action rather than abstract explanation.

2.3.4. Experiential learning

Experiential learning is learning by doing, which allows knowledge to be consolidated in practice: through creating, constructing, experimenting, and modeling. Matijošiūtė (2021) emphasizes that such activities strengthen self-confidence and create a positive learning experience.

In libraries, experiential learning is implemented through:

• Robotics classes, 3D printing, microcontroller programming;

• Construction workshops (LEGO, magnetic constructions, simple engineering kits);

• Virtual reality experiences that allow topics to be explored in ways other than books;

• Creative workshops where visitors can repair, create, and experiment.

This is a particularly suitable environment for participants with special needs, as it provides an opportunity to learn using the senses, movement, and real objects.

2.3.5. Cooperation

STEAM encourages teamwork, idea sharing, and collective problem solving. Collaboration strengthens communication, leadership, and social skills.

In libraries, collaboration among participants is evident in:

• STEAM workshops for families;

• mixed group projects (e.g., children–youth–adults);

• partnerships with schools, museums, technology centers, artists;

• participant team construction competitions, robot challenges.

For participants with special needs, collaboration provides support and helps them find the right role in the group regardless of their abilities.

STEAM principles in libraries are becoming not only a system of methodological guidelines, but also a way to create an engaging, creative, and discovery-based learning environment. STEAM helps libraries expand their role in the community—they become places where people can explore, create, collaborate, and learn throughout their lives, with activities accessible to participants with different needs.

The main principles of STEAM education: interdisciplinarity, creativity, exploration, experiential learning, collaboration.

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3. STEAM EDUCATION METHODS AND STRATEGIES

The effectiveness of STEAM activities depends on the teaching methods and strategies chosen by librarians. The choice of methods determines whether the activities will be engaging, meaningful, and responsive to the needs of participants.

This section presents various STEAM teaching methods: research-based teaching, the flipped classroom model, creative workshops, project-based and problem-based learning, design thinking, interdisciplinary and creativity-based learning, technology-based and experimental learning, as well as learning through play.

These strategies help to create activities in which participants not only receive information, but also explore, apply, create, and reflect on it. Properly selected methods transform the library into a lively, innovative, and engaging learning space where knowledge is discovered through experience.

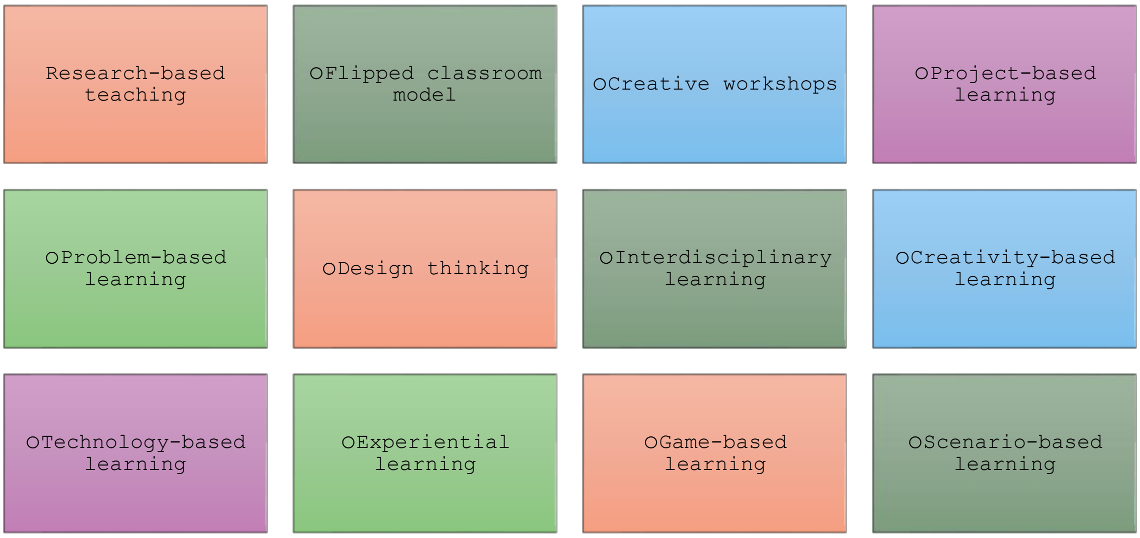

Fig. 1. STEAM teaching methods and strategies

3.1. Inquiry-based learning

Inquiry-based learning is a type of learning where participants learn based on their curiosity, ask questions themselves, and explore real phenomena. In this process, the librarian becomes not a conveyor of information, but a companion who helps participants move purposefully toward discoveries and independent conclusions.

UNESCO proposes a four-stage research cycle that can be easily adapted to STEAM activities in libraries:

- Present a challenge – formulate an interesting situation or problem that invites research.
- Encourage exploration – create conditions for analysis, testing, and experimentation.
- Observe and help summarize – ask guiding questions, help identify patterns.
- Reflect – reflect together on what has been understood, tested, and discovered.

These principles are particularly suitable for library education, as they naturally combine research, discovery, and reflection. During the research, participants formulate questions, search for information in library resources, conduct experiments, and substantiate their explanations with evidence. This mirrors the main steps of scientific research: identifying the problem, collecting data, analyzing it, and presenting reasoned conclusions. As noted by Z. R. Urbonienė (2020), this process develops critical thinking and argumentation skills, as participants must not only find the answer, but also justify it.

International research also shows that inquiry-based learning strengthens the most important 21st-century skills: creativity, communication, collaboration, and problem solving (Chu et al., 2021). These skills are particularly valuable in libraries that strive to be vibrant learning spaces.

In scientific literature, the research process usually includes the following stages: formulating questions, gathering evidence, developing explanations, linking them to scientific knowledge, and communicating the results (Lamanauskas, 2018). However, researchers point out challenges, such as finding the right balance between participant autonomy and librarian assistance (Dorier & García, 2013). However, both Lithuanian and foreign authors (Kidman & Casinader, 2017) agree that inquiry-based learning helps participants to understand phenomena more deeply and allows them to act as young researchers.

This method can be implemented in libraries in a variety of ways: through discovery stations, practical STEAM experiments, research into natural phenomena, media analysis, or construction testing. Such activities transform the library into a learning laboratory—a place where the most important thing is not the final result, but the process of discovery itself.

In summary, inquiry-based learning in library education encourages participants' curiosity, independence, ability to argue, and learning through experience and discovery (Urbonienė, 2020; Lamanauskas, 2018; Atominis Visaginas, n. d.).

Inquiry-based learning is a learning method in which participants ask questions, explore phenomena, collect and analyze evidence, develop explanations, and justify them with arguments. The role of the educator in this process is to help structure the inquiry, encourage reflection, and support participants in constructing knowledge independently.

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3.2. The flipped classroom model

The flipped classroom model is a learning method in which the traditional sequence of activities is reversed: participants first familiarize themselves with the main material independently, and during the educational process, more attention is paid to practice, exploration, creative tasks, and deeper analysis. This model is based on the idea that participants can effectively master theoretical content on their own, and that contact time should be devoted to active, experiential learning.

According to V. Targamadzė (2019), digital learning environments allow for flexible combinations of these stages and enrich teaching methods.

Research in Lithuania shows that the flipped classroom model helps to individualize learning, strengthens participants' responsibility, and increases their motivation to actively participate in activities. A. Žadeikaitė (2020) notes that advance preparation encourages learners to acquire basic knowledge independently, so during the lesson they are more confident in asking questions, discussing, and applying their knowledge in practice. S. Verkytė (2017) emphasizes in her study that a clear structure, accessible resources, and consistency in learning activities are important for the successful application of the model.

In scientific literature, the flipped classroom model is described as a community-building method in which participants actively construct knowledge and collaborate. Bergmann and Sams (2021) argue that the flipped classroom becomes a space where participants learn together, solve problems, create projects, and engage in deeper understanding. These provisions are fully in line with the philosophy of library education, where activities are focused on experience, collaboration, and exploration.

Research on blended teaching and learning, such as I. Dovsevičienė's (2024) dissertation, further reinforce the concept of the flipped classroom—she emphasizes that combining independent learning with contact activities creates favorable conditions for differentiation, coordination of learning pace, and accessibility of learning. This is also relevant in library education, where participants' levels of preparation can vary greatly. The principles of the flipped classroom are particularly easy to apply in libraries. Participants can be provided with the following in advance:

- short educational videos;
- illustrated texts or comics;
- interactive tasks.

Participants in STEAM activities come to the library already "equipped with tools in their minds," and the educator can devote all their time to practical activities: experiments, creativity, construction, testing technologies, or problem solving. For example, after learning about color theory in advance, participants can perform chemical color reactions in the library; after watching a video about electromagnets, they can build models of them; after reading a short text about robots, they can program robots.

The flipped classroom model gives library educators the opportunity to make the most of meeting time for active activities, set higher-level tasks, and create conditions for learning through experience, collaboration, and exploration (Verkytė, 2017; Targamadzė, 2019; Žadeikaitė, 2020; Dovsevičienė, 2024; Bergmann & Sams, 2021).

The flipped classroom model is a learning method in which participants master the main theoretical material independently in advance, and during educational activities, they focus most of their attention on practice, collaboration, problem solving, and deeper analysis of the content. This method allows contact time to be transformed into an active learning space where participants construct knowledge through action, exploration, and reflection.

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3.3. Creative workshops

Creative workshops are a practice-based learning and creative method in which participants engage in open, experimental activities that encourage self-expression, collaboration, and problem-solving. According to V. Židžiūnaitė (2017), creative workshops provide a safe space for trials and experiments, where the most important thing is not the final result, but the creative process itself. Library visitors are given the opportunity not only to observe, but also to actively create, explore, and discover, while educators act as facilitators who support participants in their search for ideas.

The essence of creative workshops is open-ended tasks that encourage creativity, where there is no single correct solution. Educational literature notes that such activities develop critical thinking, decision-making skills, and the ability to collaborate (Vaišnorienė, 2020). This is particularly relevant in STEAM education, where participants can create prototypes, construct, experiment with materials, or try out different technologies. Such activities help the library become an open, creative, and innovative learning space that encourages curiosity and self-expression.

It is recommended to open creative workshops in libraries when the aim is to develop several competencies at the same time: creativity, problem solving, teamwork skills, and cultural awareness. In libraries, this can be achieved through art workshops, construction labs, robotics creative activities, design thinking tasks, sensory workshops, or thematic creative sessions. During the workshops, participants can create stories, explore the properties of materials, try out technologies, or solve common challenges, thus creating an atmosphere of community and friendly learning.

Creative workshops in library education are an effective method that allows participants to experience the joy of creation, develop various skills, and discover their potential, while allowing the library to become a modern, interactive, and engaging learning space (Židžiūnaitė, 2017; Vaišnorienė, 2020).

Creative workshops are an interactive, experiential learning method where participants create, experiment, and solve open-ended creative tasks based on their own ideas and collaboration. In creative workshops, the most important thing is the creative process itself – experimentation, exploration, and self-expression – while the educator acts as a facilitator, helping participants to discover, try, and reflect.

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3.4. Project-based learning

Project-based learning is a learning method in which participants acquire knowledge and skills by working on real-life, complex, and long-term projects. This method encourages participants to explore, ask authentic questions, plan activities, gather information, and strive for tangible results. In library education, project-based learning is particularly suitable for STEAM and community activities, as it allows for the creation of real products: exhibitions, prototypes, research presentations, creative solutions, or thematic displays.

V. Targamadzė (2019) notes that project-based learning is an excellent environment for developing critical thinking, problem solving, and creativity. When working on projects, participants plan activities themselves, share responsibilities, make decisions, and present their results. Library educators can use this to create activities in which participants pursue a common goal: creating a comic book, designing a "dream library," preparing a local history exhibition, conducting an environmental study, or creating a thematic STEAM model.

One of the essential features of project-based learning is an authentic, motivating question or problem that participants explore. R. Stakėnienė (2017) argues that the method is most effective when the project topic is related to the real world, community needs, or the personal experiences of the participants. Such topics are particularly easy to find in libraries: local history, cultural heritage, community challenges, library space improvement, or sustainability issues.

During the project, participants collect information, analyze sources, consult with an educator, use library resources, discuss, and create a final product that they present to the community. This process gives the learning a clear structure and helps participants understand how their work contributes to real change or value creation.

In summary, project-based learning in library education creates conditions for meaningful, sustainable, and engaging activities that foster independence, creativity, collaboration, and connection to the real world (National Education Agency, 2020; Targamadzė, 2019).

Project-based learning is a learning method in which participants acquire knowledge and skills by working on real, meaningful, and complex problems or projects. According to PBLWorks (Buck Institute for Education), project-based learning occurs when students investigate an authentic question or challenge, plan and carry out activities, create a tangible product or solution, and publicly present their results. This method emphasizes inquiry, critical thinking, collaboration, and learning through real-world action.

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3.5. Problem-based learning

Problem-based learning is a teaching method where learning takes place by solving complex, real-world problems rather than by presenting pre-prepared information. According to V. Targamadzė (2020), problem-based learning helps students gain a deeper understanding because knowledge is acquired through active research, problem-solving, and reasoned discussion. This method is particularly suitable for libraries because it allows the creation of learning situations that reflect real community or STEAM issues.

The essence of problem-based learning is that the participant explores, hypothesizes, and searches for solutions, while the educator becomes a consultant in the process. Problem-based learning strengthens critical thinking, creativity, and the ability to argue, as it presents real-life problems rather than tasks. Library educators can apply this method by organizing activities in which participants explore questions such as:

- How can we reduce plastic use in the community?
- How can we create a more convenient library space system?
- How can we recognize the reliability of information?
- What technologies best address specific challenges?

R. Jucevičienė (2013) emphasizes that problem-based learning promotes not only the deepening of knowledge, but also the development of social skills: cooperation, a culture of discussion, the ability to argue constructively, and sharing responsibility. This is particularly relevant in libraries, which are becoming open spaces for communication and collaboration. Participants working in groups analyze information, collect evidence, formulate solutions, and justify them, creating a dynamic and research-based learning process.

In summary, problem-based learning in library education helps to create meaningful, realistic, and problem-solving-oriented activities that develop both knowledge and life skills (Targamadzė, 2020; NŠA, 2021).

Problem-based learning is a learning method in which participants acquire knowledge and skills by solving real, open-ended problems, and learning takes place through exploration, hypothesis formation, solution searching, and reasoned discussion. In this process, the educator acts as a consultant and companion, helping participants to critically analyze information, collaborate, and justify their decisions.

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3.6. Design thinking

Design thinking is a creative problem-solving method based on a deep understanding of user needs, experiences, and emotions. The essence of design thinking is to seek solutions that are meaningful and useful to specific people, so participants constantly explore, generate ideas, create prototypes, and test them in real-life situations. According to J. Markevičienė (2020), design thinking fosters empathy, helps to better understand user experiences, and encourages the creation of innovative, people-centered solutions. This method is particularly relevant for libraries seeking to create educational programs, services, or spaces that meet the needs of different visitors.

The design thinking process usually involves five stages: understanding, insight, idea generation, prototyping, and testing. This method helps participants move from problem investigation to creative solution development, while feedback and continuous prototype refinement encourage learning from mistakes. In libraries, this method can be applied when organizing activities in which participants solve real community problems, such as:

- How to make bicycles more accessible to children with disabilities?
- How to adapt library spaces for sensory visitors?
- How to create attractive and functional reading areas for young people?
- How to improve the library's information search experience?

Educational research emphasizes that design thinking helps to develop teamwork skills, creativity, problem-solving, and technological literacy (Vaišnorienė, 2019). In libraries, participants can create mock-ups, construct prototypes, test and refine ideas, analyze user reactions, learn to justify decisions, and work in groups.

Design thinking in library education provides an opportunity to combine empathy, creativity, and practical problem solving, and the solutions created become not only a learning outcome but also a real contribution to the well-being of the community (Markevičienė, 2020; National Education Agency, 2021).

Design thinking is a creative method for solving real-world problems, in which solutions are developed based on a deep understanding of user needs and experiences, idea generation, prototyping, and continuous testing. This method encourages empathy, creativity, and iterative learning, with the educator acting as a facilitator of the process, helping participants to create meaningful solutions that can be applied in real contexts.

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3.7. Interdisciplinary learning

Interdisciplinary learning is a teaching method in which different areas of knowledge are combined into a single activity, topic, or project so that participants (children, young people, or adults) can more clearly understand the connections between disciplines and apply their knowledge in different contexts. This type of education helps to understand that in real life, problems and phenomena are not divided into subjects – they naturally overlap with mathematics, arts, natural sciences, technology, and languages.

A. Žygaitienė (2019) emphasizes that interdisciplinary learning encourages creativity and broader thinking, as combining knowledge from several subjects provides more opportunities to explore, experiment, and discover. This can be implemented in many different ways in libraries. For example:

- Integrating mathematics and the arts by creating geometric bookmarks or 3D constructions.
- Combining technology and biology by observing plant growth and documenting it with digital tools.
- combining history and information technology by creating interactive maps, digital exhibitions, or local history research;
- the integration of language and natural sciences by telling stories about animals or natural phenomena based on scientific information.

Such activities allow librarians to naturally combine reading, information retrieval, creativity, and exploration into a single experience.

The value of interdisciplinary learning is also revealed through an active, collaborative process. G. Subačiūtė (2021) argues that this method helps participants better understand the meaning of the teaching content, as knowledge acquires a real context and becomes easier to apply in practice. Library education that combines several disciplines encourages curiosity, strengthens participants' independence and ability to see connections between different areas of knowledge, and to create a single joint project or research.

In summary, interdisciplinary learning in libraries creates conditions for activities in which mathematics, arts, natural sciences, language, and technology become a single whole. Library visitors learn to see the world not as a collection of separate disciplines, but as a system of interrelated phenomena (NŠA, 2020; Žygaitienė, 2019).

Interdisciplinary learning is an educational method used in libraries, where knowledge and activities from several fields (e.g., natural sciences, arts, technology, language, mathematics) are deliberately combined into a single theme, activity, or project so that participants understand the connections between disciplines and are able to apply their knowledge in real-world contexts.

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3.8. Creativity-based learning

Creative learning is a learning method based on the idea that learning is most effective when students can create, experiment, interpret, and convey information in their own way, thus giving personal meaning to knowledge.

Creativity in this context is understood as the ability to generate new, original, and valuable ideas, solutions, or products by combining knowledge, experience, and thinking strategies in new ways. It involves flexible thinking, the ability to see phenomena from an unexpected angle, and to create meaningful connections between ideas that at first glance seem unrelated. As noted by V. Židžiūnaitė (2017), creativity in the learning process helps students not only to understand information, but also to interpret, recreate, and convey it in their own way, which leads to deeper, more meaningful learning.

Researchers (Jeffrey & Woods, 2009; Craft, 2011; Beghetto, 2021) emphasize that creativity-based learning is not a separate discipline, but rather a way of learning that enables learners to explore, ask questions, use their ideas, and create original solutions. Research shows that creative activities help to develop not only subject knowledge, but also emotional intelligence, critical thinking, collaboration, and problem solving (OECD, 2019; NACCCE, 1999).

Library educators use various forms of artistic expression in their activities: drawing, painting, sculpture, installations, movement and theatrical elements, music, digital art, and media.

For example, when creating an installation about renewable energy sources, students not only explore the principles of wind, solar, or geothermal energy, but also use their imagination and design skills to create visual solutions that allow them to demonstrate their understanding and creative interpretation.

According to A. Vaišnorienė (2019), creativity-based activities encourage students to get actively involved, increase motivation, and provide a safe space to experiment, make mistakes, and look for new solutions.

In libraries, such activities can be an excellent part of STEAM education, for example:

- creating models of natural phenomena,
- constructing interactive light installations,
- interpreting the history of the library's location through artistic means,

- creating ecological sculptures with an emphasis on sustainability and environmental conservation,
- digital creation laboratories (e.g., animation, video art, 3D modeling).

Such practices combine art, science, technology, and design thinking, transforming the library into a creative laboratory where learning becomes experiential, research-based, and meaningful.

Creativity-based learning allows the library to combine art, science, and technology into a coherent educational process. This method encourages the free expression of ideas and creative problem solving, allowing students to create original, personally meaningful products and experience learning as a creative, discovery-based process (Židžiūnaitė, 2017; Beghetto, 2021; Jeffrey & Woods, 2009).

Creative learning is an educational method in which learning takes place through creative activities, idea generation, and self-expression, combining knowledge with imagination, experimentation, and the search for new solutions. This form of learning encourages learners to actively create, explore, and discover, rather than passively accept information.

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3.9. Technology-based learning in libraries

Technology-enhanced learning is an educational method that uses modern technologies to enrich, deepen, and individualize the learning process. The Lithuanian term technologijomis pagrįstas mokymasis is a non-literal translation of the English term technology-enhanced learning (TEL), which is used in the international context of education and training. This complex term is used to describe the application of information and communication technologies (ICT) in teaching and learning. Žydžiūnaitė, V., & Rutkienė, A. (2014).

The integration of technology into educational activities helps to make complex phenomena easier to understand, develops problem-solving skills, and strengthens student motivation. The modern library is becoming a space not only for information but also for technological experiences, which is why this method is particularly relevant to the educational activities of librarians.

Technology-based learning in libraries can include a variety of tools: robotics, programming, 3D modeling and printing, artificial intelligence tools, virtual reality (VR) and augmented reality (AR) solutions. Research in Lithuania shows that these technologies increase participant engagement and encourage them to explore and creatively apply their knowledge in real-life situations (Rekašienė, 2021). For example, 3D modeling allows not only to create a digital object, but also to see it in its real form, which gives learning a tangible, practical value.

Library educators can apply this method in many different ways:

- 3D technologies: allow participants to model objects using software (Tinkercad, Fusion 360) and print them with a 3D printer.
- Robotics and programming: use LEGO Education, Ozobot, Bee-Bot, or micro:bit kits for programming basics and problem solving.
- VR/AR tools: apply virtual or augmented reality to explore history, natural sciences, architecture, geography, or cultural heritage.
- Artificial intelligence: use AI tools for creative writing, illustrations, text analysis, or personalized learning.

According to R. Subačiūtė (2020), technology not only increases participants' interest in activities, but also makes it easier to differentiate education and adapt tasks to different ability groups, which is particularly important in libraries that work with visitors of different ages and needs.

Technology-enhanced learning is an educational approach that uses digital, interactive, and innovative technologies to enhance the learning process, increase participant engagement, and enable learning in a variety of ways.

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3.10. Experiential learning

Experiential learning is a learning method in which participants acquire knowledge by actively exploring, experimenting, performing practical actions, and reflecting on their experiences. According to A. Kiaunytė (2019), learning through experience promotes deeper understanding because participants not only receive information but also discover it themselves. This is particularly important in modern libraries, which are becoming not only spaces for information, but also for experiential learning – places where visitors can freely experiment, make mistakes, discuss, and create.

Kolb's theory, widely discussed in Lithuanian educational literature, emphasizes four stages of experiential learning: concrete experience, reflection, theory connection, and new trial (Kolb, as cited in Jucevičienė, 2013). This cycle can be applied very naturally in libraries, for example, in STEAM activities. In libraries, this cycle naturally blends into STEAM education. For example, participants can:

- conduct an experiment by exploring water, mixing chemicals, or constructing a mechanism,
- discuss what happened and what results they observed,
- relate their experience to theoretical knowledge,
- repeat the activity by changing the conditions to test new hypotheses.

In this way, a simple test becomes a full-fledged link in the experimental learning process.

Researcher A. Žadeikaitė (2017) emphasizes that practical and experimental activities foster curiosity, creativity, independence, and problem-solving skills. This methodology is particularly effective in libraries, as visitors can learn without the pressure of assessment, at their own pace and according to their personal interests. Educators can organize "mini-laboratories," creative workshops, sensory explorations, testing stations, or thematic experiential zones where children, young people, and adults independently explore phenomena and discover their patterns.

In summary, experimental learning in libraries is not only possible but also highly valuable. It encourages active engagement, exploration, and natural learning through experience, and provides library educators with the opportunity to create dynamic, creative, and science-based activities (Kiaunytė, 2019; Jucevičienė, 2013).

Experiential learning is a learning method in which participants acquire knowledge by actively exploring, experimenting, performing practical actions, and reflecting on their experiences.

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3.11. Gamification

Gamification is becoming an increasingly common strategy in library activities, helping to increase visitor motivation and engagement. According to M. Paliulienė (2020), gamification is the application of game elements in education or other activities to strengthen the internal motivation of learners. This means that librarians can use point systems, challenges, progression steps, or symbolic rewards to make reading and learning a more engaging experience.

In their book The Winning Edge, K. Werbach and D. Hunter argue that gamification thinking helps organizations create meaningful, consistent, and motivating user experiences (Werbach & Hunter, 2015). They propose a gamification model consisting of three levels:

- dynamics (emotions, narrative, motivation);
- mechanisms (challenges, tasks, competition, collaboration);
- elements (points, badges, levels, leaderboards).

This structure allows libraries not only to add a gamified touch to their activities, but also to strategically plan how to maintain reader engagement in the long term.

Gamification can improve the learning experience for both children and adults. R. Rimkevičienė (2023) emphasizes that gamified learning scenarios increase adult engagement, help create a positive emotional connection with learning activities, and encourage feedback. In the context of libraries, this can be applied in various ways: by organizing reading missions, educational orientation activities, escape rooms, creative tasks, or thematic game programs.

In summary, gamification in the work of a librarian provides an opportunity to combine information education with interactive, experiential activities. Purposefully applied game thinking can improve the attractiveness of library services, promote community spirit, and strengthen the culture of reading (Werbach & Hunter, 2015).

Gamification is the use of game elements, mechanics, and principles in non-game activities to increase people's engagement, motivation, and behavioral change.

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3.12. Scenario-based learning

Scenario-based learning (SBL) is a methodology in which participants learn by analyzing real or realistic situations, applying their knowledge to solve complex problems, and reflecting on their decisions. Research shows that scenario-based learning increases student engagement, motivation, and ability to apply knowledge in practice. For example, a qualitative study revealed that scenario-based e-learning STEM laboratories significantly increase students' interest in STEM subjects and their achievements (Proudfoot, 2017). Another study showed that the use of scenarios in the STEM project design process improves future teachers' 21st-century competencies and attitudes towards integrated STEM teaching (Çeliker, 2020). Research by engineering students also confirms that the scenario type as a form of problem presentation influences the problem-solving process and skill formation (Norris et al., 2022).

In library education, the SBL method can be successfully applied in STEAM activities and project-based activities, where participants become decision-makers, researchers, or creators. For example, participants can be presented with an authentic situation in the library space:

"Noise levels in the area have increased – how can we create a sensory reading room where people can feel calm and safe?" Working in teams, participants analyze the problem, formulate questions, collect information, plan actions, create prototypes of solutions, and present them. It is important that the scenario is:

- authentic – related to real experiences or community needs,
- engaging – with a clear challenge and motivating context,
- open to solutions – allowing different paths to be chosen and different strategies to be developed.

In this way, the use of scenarios promotes critical thinking, problem solving, argumentation, creativity, and collaboration. According to Proudfoot (2017), scenario-based learning increases participant engagement because they are not just "learning about a situation" but actually acting in the situation.

The role of the educator in the SBL process is extremely important—they help participants delve into the problem, moderate activities, ask targeted questions, and create conditions for reflection. This is particularly consistent with the logic of library education, where learning often takes place through collaboration, exploration, and creation without the pressure of formal assessment. Research (Norris et al., 2022) emphasizes that the structure, clarity, and space for reflection in a scenario directly affect the quality of learning outcomes.

In summary, scenario-based learning in library education provides an opportunity to create engaging, meaningful, and real-life projects in which participants become active agents. In this process, the educator acts as a guide, helping to analyze the problem, find solutions, and reflect on the learning experience, while the library acts as a creative space where problems become opportunities to learn and create.

Scenario-based learning is a methodology in which participants learn by analyzing real or realistic situations, applying their knowledge to solve complex problems, and reflecting on their decisions.

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4. PLANNING AND ORGANIZING STEAM ACTIVITIES IN LIBRARIES

4.1. Adaptation of physical and virtual spaces for STEAM activities

Modern libraries are increasingly becoming dynamic laboratories for creativity and learning, integrating both physical and virtual spaces into STEAM education. Since STEAM activities are based on exploration, experimentation, and the use of technology, library environments must be adapted to a range of activities, from creative workshops to complex technical projects. Library spaces should be reorganized to accommodate a variety of activities, giving students the opportunity to explore different areas of science, technology, and art.

Research shows that transforming physical spaces into creative workshops is one of the most effective ways for libraries to become STEAM learning centers. Such spaces are equipped with tools for creating, constructing, and experimenting: 3D printers, soldering stations, textile equipment, laser cutters, microcomputers, and other technological tools. These tools give students the opportunity to apply the principles of science, engineering, and design in practice, as noted by Julian and Parrott (2017).

Physical library spaces also often feature robotics and engineering zones that use LEGO robots, programming kits, and construction materials. This allows participants to carry out project work, test algorithms, and construct working prototypes. In addition, media and sound studios are increasingly appearing in libraries—spaces with podcast recording, filming, editing, and music creation equipment that integrate an artistic component into STEAM activities.

Levy (2021) emphasizes that these spaces must not only be equipped with equipment, but also be flexible: modular furniture solutions allow the library layout to be quickly transformed from a lecture space to a practical workshop area or group work space. In this way, the library becomes a multifunctional learning environment where both formal and informal STEAM activities take place.

An important part of the library's physical spaces remains open reading and research corners for individual information searches, project modeling stages, or scientific source analysis. These spaces complement the creative zones, providing conditions for both creativity and theoretical preparation.

Physical STEAM spaces must be not only functional but also engaging. This means that they must be convenient for people with different needs, ensuring access for all students, including those with disabilities. It is necessary to provide a safe infrastructure for experimental activities: electrical connections, network access, quality lighting, and ventilation. This is particularly emphasized in studies on library makerspace areas, which, as noted by academic sources (Enhancing Library Services..., 2019), help to reduce the technological divide and ensure equal opportunities to work with advanced technologies.

Virtual spaces are an equally important part of STEAM libraries. Virtual platforms and distance learning allow students to continue their projects regardless of their physical location. Labangon (2018) points out that virtual laboratories, programming environments, 3D modeling tools, and other digital tools provide opportunities to explore various STEAM topics both individually and collaboratively via remote access. Virtual education expands library services by enabling remote lessons, lectures, and training, as well as the creation of digital project galleries where students can share their work.

Digital STEAM spaces complement physical ones: virtually created models (e.g., in the Avogadro program) can be printed in the library, algorithms tested remotely can be applied in robotics practices, and ideas tested in online simulations can be turned into real prototypes. This hybrid approach is particularly emphasized by contemporary education leaders, including TinkRworks (2024), who argue that by combining virtual consultations, digital resources, and physical space equipment, libraries can become comprehensive STEAM learning centers.

Thus, the integration of physical and virtual spaces allows libraries to create a modern, accessible, and innovative STEAM environment that responds to the diverse learning styles, needs, and abilities of students. Libraries are becoming not only sources of information, but also places for creativity, research, and experimentation.

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4.2. Involvement of partners and the community in STEAM activities

STEAM activities in libraries are most effective when they are developed in collaboration with various institutions and partners. Schools can contribute by implementing joint projects, organizing lessons in the library, or integrating STEAM modules into the educational process. Universities and research institutes provide opportunities to invite scientists to give lectures, organize practical laboratories, and develop mentoring programs. Science centers, such as the Museum of Science and Technology or the Science Island, can contribute by organizing interactive exhibitions and science days in library spaces.

Creative industries also play an important role – designers, animators, music creators, and digital art specialists who help combine technology with art. Non-governmental organizations can initiate projects for children and young people and promote inclusive education, while businesses—technology providers, start-ups, or innovation labs—provide access to the latest solutions and practical knowledge.

Equally important is community involvement, which can be achieved through open competitions and hackathons, creative marathons, mentoring programs, exhibitions and projects created by residents, parent-child workshops, or mobile STEAM laboratories traveling around the city or region. Such partnerships provide libraries with additional resources, competencies, and ideas, while involving the community in active creation and the shared learning process.

4.3. Accessibility of STEAM activities for different target groups

The accessibility of STEAM activities in libraries to different age groups and needs is one of the key factors ensuring their social and educational value. Libraries, as open and accessible spaces, enable children, young people, adults, and seniors to engage in STEAM activities, regardless of their previous experience or social context.

For children, STEAM activities are usually organized in a playful way—through experiments, construction, robotics, or creative workshops that encourage curiosity and early interest in science and technology. Young people are offered more complex activities focused on problem solving, programming, digital design, or project work, as well as learning about careers in STEAM fields. For adults, STEAM programs help to strengthen digital and technological literacy, acquire new skills or retrain, while for seniors, they are adapted to emphasize the practical use of technology, a slower pace of learning, and social interaction.

Target Group	**Adapted STEAM Activities**
Children (ages 3–10)	• Simple robotics activities (Bee-Bot, LEGO). • Experiments with water, light, and sound. • Creative workshops (construction, drawing, animation).
Adolescents and Youth (ages 11–18)	• Programming (Python, Scratch, JavaScript). • 3D modeling and 3D printing. • Virtual reality, video production, introductory music production. • Engineering projects using Arduino and similar tools.
Adults	• Digital literacy training. • Design, photography, and editing workshops. • Technology awareness activities (artificial intelligence, data analysis).
Seniors	• Digital skills useful in everyday life. • Creative experiential projects (e.g., digitization of family histories). • Intergenerational activities together with youth.
Individuals with Special Needs	• Adapted educational activities using sensory, interactive, and auditory solutions. • Universal Design for Learning (UDL) in educational programs. • Accessible technological tools (large fonts, specialized keyboards).

Table 1. Examples of STEAM Activities

4.4. Planning and organizing STEAM activities in libraries

STEAM ugdymo planavimas bibliotekoje yra kompleksinis procesas, reikalaujantis nuoseklios strategijos, tinkamų infrastruktūrinių sprendimų ir bendruomenės poreikių analizės. Šiuolaikiniai tyrimai akcentuoja, kad bibliotekos, įgyvendinančios STEAM programas, tampa ne tik informacijos centrais, bet ir dinamiškomis mokymosi laboratorijomis, kuriose vyrauja tyrinėjimas, kūryba ir projektinis mokymasis (Mitchell, 2020). Todėl STEAM veiklų planavimas turi būti orientuotas į lankytojų poreikius, prieinamumą, technologijų integraciją ir tarpdisciplininius ugdymo principus.

The first step in planning STEAM activities is to assess the context and audience of the library. Biddle and Gowen (2023) emphasize that planning activities is impossible without a clear understanding of who uses the library's services and what skills they need: different age groups have different technological abilities, so STEAM programs must be differentiated. A similar point is made in the STEAM Up Your Library Guide, which recommends analyzing community needs and assessing technical capabilities before developing activities (Space Science Institute, n.d.).

The second important aspect is to clearly define STEAM goals. Research shows that libraries should choose priority areas: whether to strengthen digital literacy, create prototypes, develop programming skills, or encourage interdisciplinary creativity (Shtivelband, 2017). Setting goals helps to clearly plan the content and resources for activities.

It is then important for the library to develop age- and skill-appropriate STEAM activity content. Mitchell (2020) notes that flexibility of activities is one of the key elements of successful STEAM programs—activities must be adapted to children, young people, and adults alike. Research confirms that libraries are becoming important spaces for non-formal education, where people can learn at their own pace and according to their individual needs (Ogunmodede & Adedeji, 2024).

The preparation of physical spaces is also a key point in planning STEAM activities. The STEAM Up Your Library Guide recommends creating creative workshops, robotics zones, media studios, and open computer workstations, as well as ensuring electricity, security, and network infrastructure. Shtivelband (2017) emphasizes that flexible spaces, mobile furniture, and easily adaptable areas directly increase the variety of activities and participant engagement.

Partnerships must also be considered in the planning process. Research shows that collaboration with schools, universities, technology companies, and local experts allows for the expansion of STEAM activities and access to lecturers, equipment, and methodological materials (Biddle & Gowen, 2023). Such partnerships strengthen the role of libraries in the learning ecosystem and provide opportunities to develop long-term programs.

Another necessary step is to strengthen the competencies of library staff. Shtivelband (2017) and Mitchell (2020) emphasize that librarians are becoming not only information specialists but also technology mentors, so they need a system of continuous training that allows them to master the basics of robotics, programming, media creation, or 3D modeling.

Finally, effective planning of STEAM activities includes testing and evaluating programs, covering participant engagement, acquired competencies, visitor feedback, and the relevance of programs to the community (Biddle & Gowen, 2023). Evaluation data allows for the adjustment of activities, the improvement of educational tools, and the assurance that STEAM programs remain sustainable over time.

In summary, successful STEAM education planning in libraries is based on a clear strategy, space and resource management, partner involvement, and continuous program improvement. In summary, successful STEAM education planning in libraries is based on a clear strategy, space and resource management, partner involvement, and continuous program improvement. By following research-based principles, libraries can become innovative learning centers that contribute to the technological, creative, and cultural growth of the community.

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4.5. Development of STEAM educational programs

The STEAM educational program in the library can be developed according to the structure of the STEAM educational activity description provided in Appendix 1. Such a description helps to ensure that STEAM activities are focused, high-quality, and meet educational goals.

The activity description begins with a theme and title that should reflect the interdisciplinary nature of STEAM and be appealing to the target audience. A duration of 60 minutes is particularly suitable for library education, as it allows for the introduction, practical activities, and reflection to be balanced while maintaining the participants' attention. The abstract briefly presents the idea of the activity, its relevance, and its connection to STEAM education and library functions. It is recommended to prepare the abstract after all activities have been planned.

The content of STEAM activities is described in terms of areas of achievement (S, T, E, A, M), clearly indicating which areas are primary and which are integrated. This allows library education to be linked not only to technology or creativity, but also to natural sciences, mathematical thinking, or engineering solutions. The competencies developed in participants are indicated: communication, cultural, creativity, digital, cognitive, citizenship, and social and emotional (see Figure 2). In library STEAM activities, these competencies are developed through collaboration, creative tasks, problem solving, and reflection.

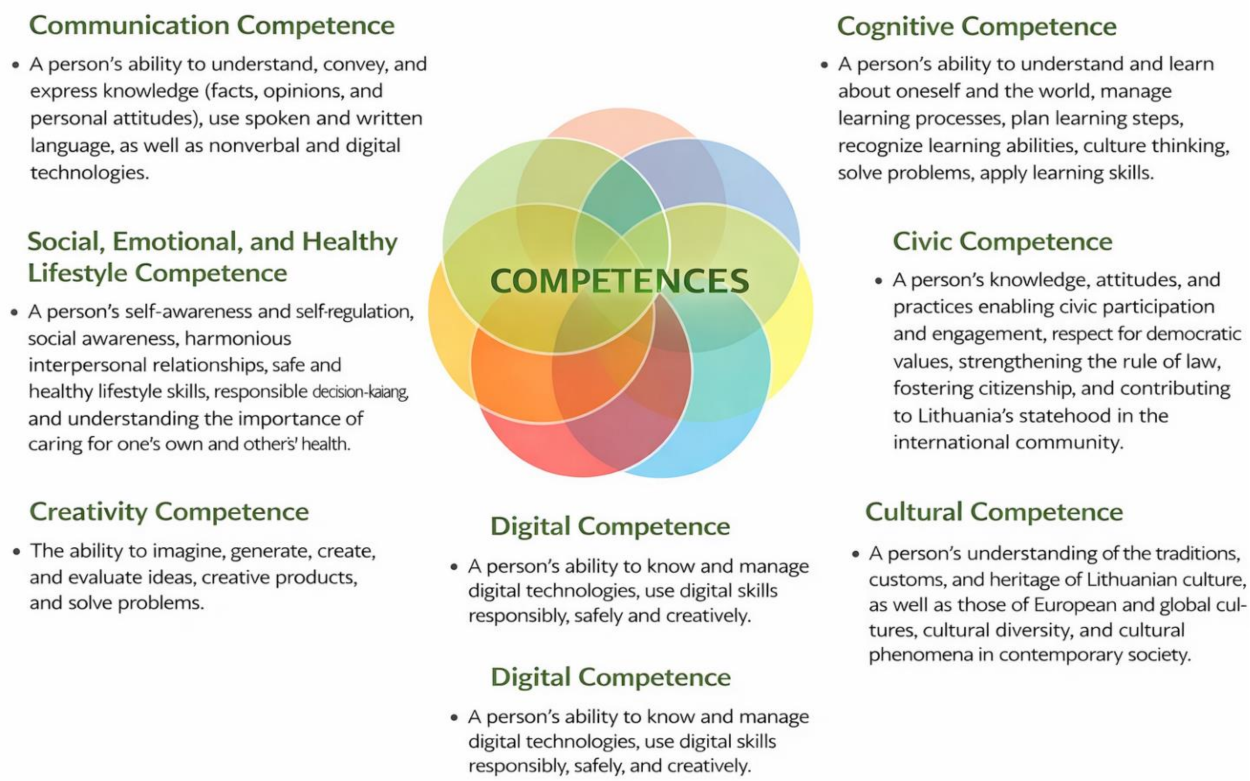

Fig. 2. Competence content. Source: www.emokykla.lt

The objectives and tasks of the activities are formulated in such a way that they focus not only on the transfer of knowledge, but also on practical learning, problem solving, independence, and critical thinking. The methods and strategies of the activity usually include experimentation, project work, discussions, creative workshops, and research, which are particularly well suited to the informal learning environment of libraries. This requires tools and equipment ranging from simple creative tools to digital technologies, and, if necessary, additional tools that increase the flexibility of the activity.

The implementation of STEAM activities is detailed in the stages of the activity content. Before the activity and during the introduction (about 5 min.), the educator motivates the participants, finds out about their experience, and presents the task. In the practical activity (about 30 min.), participants actively experiment, create, and solve problems, while the educator acts as a consultant and mentor. The presentation of the results of the activity (about 15 min.) encourages communication and reflection skills, while reflection (about 10 min.) allows participants to evaluate their experience, achievements, and emotions.

Finally, there is an assessment and evaluation of achievements, recommendations for further learning, and sources and literature that provide opportunities to continue the activity independently. This structure of the STEAM education activity description helps libraries to systematically create educational programs that are accessible, engaging, and meaningful to different age groups and comply with the principles of the modern learning ecosystem.

4.6. Adapting STEAM activities for people with special needs

The opportunities for participation of individuals with special needs in STEAM activities in libraries are closely linked to the mission of libraries as open, democratic, and inclusive community spaces. According to Corrall (2019), contemporary libraries increasingly function as centers of social and educational inclusion, providing learning opportunities for all members of the community regardless of their physical or cognitive abilities.

One of the main methodological foundations for ensuring inclusion is the application of the principles of Universal Design for Learning (hereinafter – UDL). Meyer, Rose, and Gordon (2014) emphasize that UDL enables the creation of a flexible learning process that can be adapted to diverse learners' needs by offering multiple means of information representation, activity performance, and engagement. By applying these principles, libraries can ensure that STEAM activities are accessible to individuals with physical, sensory, cognitive, or social challenges.

Ensuring physical accessibility involves not only access to library premises but also ergonomically adapted workstations, height-adjustable tables, clear spatial layouts, and a safe, orientation-friendly environment. Hill (2013) argues that the physical environment has a direct impact on the level of participation and independence of people with disabilities. For participants with sensory sensitivities, calmer and less stimulating spaces are particularly important, as well as the ability to regulate lighting, sound, or the pace of activities. For individuals with cognitive and learning difficulties, STEAM activities, according to Basham, Israel, and Graden (2020), should be broken down into clear, sequential stages, using visual instructions, examples, and demonstrations that help improve task comprehension and reduce learning-related anxiety.

No.	STEAM Activity Aspect	Applied Methods / Tools	Practical Example in the Library	Impact on Participants
1.	Activity Structure	Division of activities into clear stages	The task is completed in 4 steps with time markers	Easier orientation
2.	Instruction Delivery	Visual instructions (pictograms, diagrams)	Posters displaying the activity process near workstations	Better task comprehension
3.	Learning Support	Demonstration of examples	A previously created model or prototype is shown	Reduced learning anxiety
4.	Action Demonstration	Step-by-step demonstration	The educator demonstrates actions on a screen	Increased self-confidence
5.	Learning Pace	Slow, predictable pace	Planned pauses for questions	Reduced cognitive load
6.	Work Organization	Individual or small-group work	Teams of 2–3 participants	Greater engagement
7.	Reflection	Simple reflection tools (emotion charts, stickers)	Participants choose an emotion after the activity	Improved awareness of experience

No.	STEAM Activity Aspect	Applied Methods / Tools	Practical Example in the Library	Impact on Participants
8.	Learning Environment	Calm, structured space	Dedicated STEAM area without excessive stimuli	Sense of safety

Table 2. Adaptation of STEAM Activities for Individuals with Cognitive and Learning Difficulties

Technology provides additional opportunities for inclusion in STEAM activities. Assistive digital tools—such as screen readers, voice recognition software, specialized applications, tactile or hybrid technologies—enable individuals with special needs to actively participate in technological and creative processes. King and Pringle (2019) emphasize that appropriately selected technologies not only compensate for certain functional limitations but also help to reveal learners’ strengths in STEAM activities. Libraries’ capacity to organize activities on an individual basis or in small groups, combined with elements of mentorship, creates conditions for personalized learning and enhances participants’ self-confidence.

An equally important factor is the preparedness of educators and librarians. Subramaniam et al. (2017) note that inclusive STEAM activities are not possible without professionals who are able to recognize diverse needs, flexibly adapt activities, and create a supportive learning environment. Strengthening competencies in inclusive education, along with collaboration with special educators, non-governmental organizations, and families, enables libraries to develop meaningful educational experiences that uphold dignity.

In conclusion, libraries that purposefully apply the principles of universal design, inclusive education, and STEAM methodology not only provide individuals with special needs opportunities to engage in technological and creative processes, but also contribute to their social inclusion, the strengthening of self-esteem, and full participation in the community learning ecosystem.

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4.7. Application of Sustainability Principles in Library STEAM Activities

The sustainability dimension of STEAM activities in libraries encompasses environmental, social, educational, and institutional aspects, all of which are closely linked to the role of libraries as open and community-accessible learning spaces. Scholars emphasize that contemporary libraries function as part of sustainable learning ecosystems, creating conditions for the development of long-term educational and social value (Corrall, 2019).

Environmental sustainability in STEAM activities is reflected in the responsible use of resources and the integration of sustainable practices into educational content. When organizing STEAM activities in libraries, it is important to consider not only the creative process itself but also the purpose and subsequent use of the products created. Such an approach promotes meaningful creation and helps to avoid the accumulation of short-lived objects intended only for temporary use during activities. For example, greeting cards, leaflets, posters, drawings, or digital products created during STEAM activities can be used for promoting library events, informing the community, educational exhibitions, or social initiatives. UNESCO (2017) emphasizes that education for sustainable development should focus on conscious decision-making and responsibility for the consequences of one's actions, including the use of resources.

Social sustainability in library STEAM activities is associated with inclusion and the provision of equal opportunities. By offering free or low-cost STEAM activities, public libraries contribute to social cohesion and the reduction of the digital divide (Subramaniam et al., 2017). Aabø, Audunson, and Vårheim (2010) argue that libraries function as important community meeting places where shared, community-beneficial outcomes are created. Incorporating the real-world application of created products into activities strengthens participants' engagement and their understanding that their creative work has tangible value.

Educational sustainability in library STEAM activities is grounded in the principle of lifelong learning and an orientation toward the development of long-term competencies. STEAM activities in which participants not only create but also reflect on where and how their products will be used foster critical thinking, responsibility, and the ability to plan processes from idea to final outcome (Mitchell & Nichols Hess, 2020). Such practices help participants understand the relationship between technology, creativity, and real-world needs.

Institutional sustainability is expressed through purposeful activity planning and efficient resource use. Thoughtful utilization of created products enables libraries to use materials, time, and human resources more effectively, while also strengthening the alignment of STEAM activities with library strategic directions and community needs (IFLA, 2015). In addition, the continuous development of librarians' competencies and the application of inclusive education methods contribute to sustainable organizational development (Meyer et al., 2014).

In summary, sustainability in library STEAM activities involves not only responsible resource use but also meaningful creation, where each activity and the product developed during it has a clear purpose and practical application. In this way, libraries generate long-term value for the community, promote responsible use of technology and creative solutions, and foster a conscious, sustainability-oriented society.

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Appendix 1. DESCRIPTION OF STEAM EDUCATIONAL ACTIVITY

DESCRIPTION OF STEAM EDUCATIONAL ACTIVITY
(Title of the Description)

Topic		
Duration		
Abstract		
STEAM education achievement areas and developed skills		
S (natural sciences)		
T (technologies)		
E (engineering)		
A (arts, other subjects)		
M (mathematics)		
Participant competency development ***(underline the competency and its component or components)***		
Goal of the activity		
Operational objectives		
Operational methods		
Operational strategies		
Operational methods and strategies		
Additional measures that are needed to implement the activity		
Content of the activity		
Stages	Educator's activities	Participants' activities
Before the activity		
Introduction, motivating participants, exploring their		

experience, and discussing the activity's objectives ***(15 min.)***		
Practical activity - experimentation ***(30 min.)***		
Presentation of activity results ***(15 min.)***		
Reflection ***(10 min.)***		
Assessment evaluation and self-evaluation		
Recommendations		
Sources		
References		
Recommended measures		
Recommended books for completing the task		