STEAM Education for an Innovative Approach to Sustainability: Perspectives of Future Preschool Educators and Teachers

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Modern education is increasingly viewed through the lens of sustainable development, with a focus on pedagogical practices that foster competent, creative, and socially responsible individuals. The STEAM approach integrates science, technology, engineering, the arts, and mathematics to foster creativity, critical thinking, and transdisciplinary problem-solving among learners. This approach directly contributes to education for sustainable development by enhancing the quality of education, gender equality, and innovation. The paper explores teacher education students' awareness of STEAM, their attitudes toward its use, and their readiness to apply it in future teaching. A qualitative study was conducted through focus groups with students from various teacher education programmes (natural sciences, social sciences, and arts). Students' attitudes were analysed, and the perceived benefits, obstacles, and needs for additional support in the implementation of STEAM were identified. The results reveal limited formal education about STEAM, but also a strong motivation among students to apply this approach, particularly in contexts that foster innovation, inclusion, and the connection of theoretical knowledge with real-life situations. Identified challenges include a lack of practical training, insufficient institutional support, and limited resources. Participants highlighted the need for greater integration of STEAM-related content in university curricula. In conclusion, the findings underline the necessity of systemic integration of STEAM education in teacher and preschool educator training programmes, as a key factor in developing sustainable educational practices. Supporting future teachers and educators in acquiring competencies for transdisciplinary

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learning and innovative teaching may be crucial for advancing education for sustainable development.

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Theoretical Background

The integration of science, technology, engineering, the arts, and mathematics (STEAM) is increasingly recognised as a transformative educational model for developing essential twenty-first-century competencies, including creativity, critical thinking, collaboration, and problem-solving. Research in this area spans various educational levels, from preschool to university, and includes analyses of both learning outcomes and the perceptions of prospective educators. Recent studies affirm the pedagogical value of STEAM, demonstrating its positive impact on student engagement and transdisciplinary learning. Sánchez Milara and Cortés Orduña (2024) highlight STEAM's role in real-world problem-solving and student-centred learning. Papagiannis and Pallaris (2024) report improved critical thinking and collaboration through makerspace interventions in computer science. These findings reflect a broader shift towards STEAM as a strategy for equipping learners to address complex, real-world challenges. Still, despite growing academic interest and its inclusion in educational discourse, the implementation of STEAM – particularly within higher education and teacher training programmes – remains inconsistent.

Recent research indicates an increasing academic focus on in-service teachers' attitudes toward STEAM education. For instance, Kalliontzi (2022) conducted a study examining secondary education teachers' attitudes toward implementing STEM in the classroom, revealing a generally positive outlook but also highlighting concerns about practical implementation challenges. Similarly, Berry et al. (2025) explored Australian secondary school teachers' perceptions and practices related to integrated STEM education, noting significant variations in understanding and application, which underscores the need for further professional development and support. Additionally, Zhou et al. (2023) performed a meta-analysis on the impact of professional development programmes on in-service STEM teachers' self-efficacy, confirming that targeted training significantly enhances teachers' confidence and effectiveness in delivering STEM education. Still, there is a

notable lack of empirical research focused on how student teachers perceive and understand this approach. This study seeks to address this gap by exploring the perceptions, self-assessed readiness, and potential barriers faced by pre-service teachers in adopting STEAM pedagogy within their future professional practice.

Additionally, studies indicate that integrating the arts into STEM disciplines fosters creativity, critical thinking, and transdisciplinary collaboration among students. For instance, Papadopoulou (2024) emphasises the significance of arts integration in cultivating essential twenty-first-century skills. A systematic review by Amanova et al. (2025) highlights the positive impact of STEAM education on learners' performance and skill development. These findings underscore the growing emphasis on STEAM methodologies to prepare students for complex, real-world challenges. An increasing number of institutions worldwide are seeking to equip student teachers with the skills necessary to implement this concept in their future professional practice (Marín-Marín et al., 2021; Deák & Kumar, 2024). These authors note that STEAM initiatives in higher education are often only partially applicable and that a unified methodology for implementing STEAM in academic institutions is still lacking. Moreover, questions arise regarding the readiness of university educators to embrace the STEAM approach and the type of training that would be necessary to prepare them for its application.

Some experimental studies have shown that the application of STEAM-based teaching in higher education has a positive influence on students' motivation across various scientific disciplines and enhances both their cognitive and psychomotor skills, encouraging them to adopt STEAM methodologies in their future careers (Šlekienė, 2019; Arpaci et al., 2023). The application of both transdisciplinary and transdisciplinary approaches is, in most cases, well received by science students, who generally demonstrate a willingness to adopt and apply this learning model in practice (Maghfiroh et al., 2023). Some authors identify the lack of training programmes aimed at enhancing transdisciplinary teaching competencies as one of the main obstacles to the practical implementation of STEAM within higher education. This trend is frequently attributed to the rigid institutional structures of universities and existing educational policies (Clarke, 2018; Sánchez Milara & Cortés Orduña, 2024).

Lupión-Cobos, Girón-Gambero, and García-Ruiz (2022), in their study on collaboration between schools and research institutions, stress the importance of problem-based learning in authentic scientific contexts. Although the study does not focus specifically on teacher training, its findings support

the view that real-world contexts and collaborative approaches are essential components of effective STEAM education. Dost (2024) further expands the discussion in research which introduces the dimension of belonging within STEM fields, drawing attention to the importance of social context in student retention-an issue equally relevant for future educators tasked with creating inclusive learning environments. Carter et al. (2021), through an analysis of an Erasmus+ project, identify institutional challenges, the absence of standardisation, and the need for transparent educational models. Their work reveals that even at the level of higher education, STEAM is not comprehensively integrated, which directly affects the preparation of future teachers.

Another aspect relevant to our research is that numerous studies have demonstrated the positive impact of STEAM education on student learning outcomes across various disciplines. These findings reinforce the need to equip pre-service teachers with the skills and confidence to implement such approaches effectively in their future classrooms. Earlier research shows that STEAM improves student achievement and fosters collaboration, critical thinking, creativity, and environmental awareness (Anggreani & Suratno, 2020; Ozkan & Umdu Topskal, 2020; Atmojo et al., 2021). Rahmawati et al. (2019) demonstrated that integrating STEAM in the teaching of chemistry significantly improves creativity and critical thinking among 11-year-old pupils. Their study, which involved problem-solving tasks related to pH value changes in the environment and their effects on living organisms, revealed that students taught using the STEAM approach achieved higher levels of knowledge and understanding compared to those in traditional classes. Mastery and understanding of biological concepts related to ecosystem functioning can be greatly improved by combining STEAM methodology with project-based learning (PjBL), as shown by Suciari and Suwono (2021). They also demonstrated greater communication skill development in the experimental group than in the control group. Similarly, Arpaci et al. (2023) found that combining STEAM and PjBL was particularly effective in teaching motion laws through a project in which students constructed rubber-band powered car models, integrating technological tools for speed and acceleration measurement and incorporating artistic design elements. Their findings clearly showed that the STEAM group achieved significantly higher motivation and knowledge acquisition than the control group.

Despite the growing body of literature examining various dimensions of the STEAM approach, relatively few studies have focused explicitly on the perceptions and preparedness of student teachers-those who are expected to apply STEAM principles in future educational settings. Most existing re-

search centres on the views and experiences of in-service teachers, leaving a notable gap in our understanding of how pre-service educators conceptualise STEAM, evaluate their own readiness, and perceive the practical challenges associated with its implementation. This study aims to examine how pre-service teachers in Bosnia and Herzegovina understand and evaluate the STEAM approach and their readiness to implement it in future teaching practice. It explores their awareness of STEAM, attitudes toward its applicability, and self-assessed competence. The research also investigates perceived barriers to practical implementation, including curricular limitations and institutional constraints. By analysing these dimensions, the study seeks to identify key factors that influence successful integration of STEAM in teacher education. The findings aim to inform future curriculum development and support strategies for STEAM-oriented pedagogy.

Research Methodology

Research Design

This study was conducted within a qualitative research framework, aiming to gain deeper insight into student teachers' perceptions of the STEAM approach across various disciplines, including the arts, natural sciences, and social sciences. The primary objective was to explore how students perceive the integration of the STEAM model into higher education, the potential benefits and challenges they identify, and the extent to which they consider this approach applicable in their future professional contexts. The focus was placed on analysing attitudes, levels of awareness, and expectations related to the integration of a transdisciplinary model into the educational system. Data were collected through focus groups in order to obtain rich, contextually grounded insights. The findings are intended to serve as a basis for future educational reforms and to inform the development of teaching strategies at the University of Banja Luka, with the aim of facilitating a more effective integration of the STEAM approach into higher education.

The research was designed as an interplay between theoretical analysis and empirical inquiry grounded in a qualitative paradigm. The method of theoretical analysis and synthesis was employed to define the conceptual foundations of the study and to review existing knowledge relevant to the research problem, thereby providing the analytical framework for interpreting the results. Empirical data were gathered through focus group discussions, a method chosen for its suitability in illuminating complex issues related to educational approaches and collective perception-building within academic programmes. Focus groups were considered the most appropriate data col-

lection method as they allow for open-ended responses and promote a more natural and dynamic exchange of ideas among participants. Unlike questionnaires or other more structured instruments, focus groups provide a flexible environment in which participants feel more comfortable elaborating on their thoughts and engaging in deeper reflection. In addition to core questions, follow-up prompts were used within the focus groups to encourage further exploration of participants' views and experiences.

Participants

The study included five focus groups (labelled FG1 to FG5), comprising a total of 25 participants ($N = 25$), all of whom were student teachers enrolled at the University of Banja Luka. The sample was selected using purposive sampling, with the intention of ensuring disciplinary diversity and relevance of participants' study programmes in relation to the potential implementation of the STEAM approach in future teaching practice.

Focus group sessions were conducted on university premises with participants' informed consent. Each session lasted between 45 and 60 minutes and was moderated using a Focus Group Protocol, which included pre-defined thematic units: awareness of STEAM, perceived benefits and challenges, applicability in teaching, training during studies, and support needs.

The research intentionally focused exclusively on students enrolled in teacher education programmes, rather than those following general academic tracks, as the aim was to explore perceptions of those who are being directly prepared for future roles in education. Particular attention was given to students from disciplines where the integration of STEAM principles is both feasible and pedagogically relevant-such as science, technology, and the arts-given their potential to apply transdisciplinary and innovative approaches in their future classrooms.

Data Analysis

A thematic analysis of responses provided by participants in five focus groups was performed, focusing on their knowledge, attitudes, perceived challenges, and possibilities for implementing the STEAM approach in education. The statements are organised according to key thematic categories and illustrated with representative quotations, accompanied by synthesised findings for each area. The labels FG1–FG5 refer to the following focus groups: FG1 – second-year students of the Pedagogy Study Programme, Faculty of Philosophy; FG2 – fourth-year students of the Physics Study Programme, Faculty of Natural Sciences and Mathematics; FG3 – third-year students of the Chem-

istry Study Programme and the Environmental Protection and Ecology Study Programme, Faculty of Natural Sciences and Mathematics; FG4 – third-year students of the Preschool Education Study Programme, Faculty of Philosophy; FG5 – third-year students of the Fine Arts Study Programme, Academy of Arts.

Following the transcription of audio recordings, the data were analysed using thematic analysis (Braun & Clarke, 2006), adopting a deductive approach. Thematic categories were pre-determined based on existing literature, the aims of the study, and the structure of the focus group protocol. A deductive strategy was deemed appropriate given the clearly defined thematic areas of interest (e. g. awareness, attitudes, challenges, applicability), which were consistent with the theoretical foundations and prior empirical findings on STEAM in education. This approach also allowed for systematic comparison across participant groups and identification of patterns within the defined thematic framework.

The final coding matrix comprised six main themes, each containing subcategories and illustrative participant quotes. Thematic synthesis was developed through iterative reading, categorisation of responses, and cross-group comparison.

The study was conducted in accordance with ethical standards for social research. All participants were informed about the purpose of the study, the data processing procedures, and the guarantee of anonymity. Participation and audio recording of the discussions were entirely voluntary, and data were used exclusively for scientific analysis.

Results and Discussion

The results of the qualitative analysis of student attitudes, presented below, are interpreted as reflections of their understanding and perception of the STEAM approach within higher education. The analysis of focus group data enables the identification of key factors influencing the acceptance and implementation of this transdisciplinary model.

Thematic Analysis of Focus Group Participants' Responses on the STEAM Approach

1. *Awareness and Understanding of the STEAM Approach* (level of awareness and conceptual understanding):

   FG1 'I heard about the STEAM approach during some lectures.'

   FG1 'The STEAM approach is quite different from the traditional meth-

od of teaching; it is based on group and team work, and it fosters critical and creative thinking.'

FG1 'The STEAM approach integrates various scientific disciplines.'

FG1 'I'm not sure what STEAM actually means, but I've heard about it at university.'

FG2 'I learned about the STEAM approach through extracurricular activities.'

FG3 'I don't know exactly what STEAM means.'

FG3 'I found out about STEAM at the Faculty of Natural Sciences and Mathematics, during a visit when I was exploring study opportunities. I noticed the word "STEAM" written on the door of a classroom.'

FG3 'An example of applying art within this approach is drawing visual representations of cell structures, the composition of algae, animals, plants, creatively illustrating chemical reactions, the structures of chemical compounds, and so on.'

FG4 'I had heard of STEM, but I didn't know there was a version that includes the arts.'

FG4 'Although we had methodology courses, we were never practically introduced to the STEAM approach.'

FG5 'I have no idea what the STEAM approach actually is.'

A significant degree of variability in the level of awareness was observed among the focus groups. Pedagogy students (FG1) demonstrated a relatively higher level of familiarity with the concept compared to others, although their understanding remained partial and fragmented. In the remaining groups, awareness was largely limited to sporadic encounters with the term through extracurricular activities or visual impressions, highlighting the need for more systematic education on STEAM within higher education.

2. *Attitudes and Perceptions Regarding the Benefits of the STEAM Approach* (positive perceptions – fostering creativity, curiosity, and motivation):

FG1 'I believe the STEAM approach aligns well with children's natural inclinations, and that if it were more widely implemented in preschools and primary schools, students' knowledge by the end of Year Nine would be significantly more functional.'

FG1 'I think pupils would learn more through practical, creative projects.'

FG1 'The STEAM approach can be applied at all educational levels, but

it is important that it be adapted to the age and developmental stage of children and students.'

FG2 'Hands-on activities enable better retention and promote the development of critical thinking.'

FG2 'This approach enhances pupils' social skills and fosters a sense of belonging and responsibility.'

FG3 'STEAM motivates pupils to actively participate and to master the material more effectively.'

FG3 'The STEAM approach is an advanced, innovative teaching concept that clearly offers advantages over traditional forms of instruction.'

FG4 'Children enjoy practical activities and experiments the most. They need to see and experience things for themselves, and this type of approach would certainly be engaging for both children and educators.'

FG4 'Children prefer learning through play, and the STEAM approach can be implemented in a playful manner as well.'

FG5 'Implementing the STEAM approach would contribute to a deeper understanding of the arts.'

Across all focus groups, positive perceptions of the STEAM approach prevail, with particular emphasis on its potential to foster creativity, practical skills, teamwork, and student motivation. Participants recognise the approach as innovative and closely aligned with children's natural interests, suggesting its applicability across various educational levels, provided it is appropriately adapted.

3. *Perception of the Challenges Involved* (obstacles to effective implementation: limited resources, insufficient training, and time constraint):

FG1 'Not everyone is prepared for teamwork.' 'It is difficult to provide the necessary conditions for implementing the STEAM approach in our kindergartens and schools – we simply lack sufficient resources.' 'A major challenge could be the lack of collegiality among educators and teachers.'

FG2 'Teachers are not adequately prepared and may be resistant to new methodologies.'

FG2 'The curriculum is rigid and does not allow for interdisciplinarity or connections between subjects.'

FG3 'Time constraints and a lack of equipment are key challenges.' 'For this type of teaching, the teacher must be well-prepared and pos-

sess comprehensive knowledge and skills across multiple disciplines, which can be problematic if they do not have a solid foundation in related scientific fields.'

FG5 'A lack of knowledge in other subject areas.'

The main obstacles to the implementation of the STEAM approach were identified across nearly all focus groups, primarily relating to a lack of resources, equipment, time, and transdisciplinary knowledge. Resistance to teamwork and to changes in educational practice was also noted, along with the rigidity of curricula, which do not encourage interdisciplinarity. These findings point to systemic challenges that would require institutional support and structural reforms.

4. *Applicability in Future Practice* (clarity of proposed implementations and subject-specific relevance):

FG1 'We must always provide support to educators and teachers, for example by delivering demonstration lessons.'

FG1 'I believe it is no longer sufficient to simply present information to children – this kind of approach can positively influence students' motivation.'

FG2 'It would be interesting to apply this approach in practice.'

FG2 'It is possible to establish a kind of subject-specific team in which teachers collaboratively address certain topics and areas, sharing ideas and perspectives.'

FG3 'I would be keen to apply the STEAM approach to topics such as photosynthesis and wastewater.'

FG3 'Modifying conditions in drug synthesis or developing a project on waste management.'

FG3 'It would be advisable to combine the STEAM approach with traditional forms of teaching throughout the academic year, rather than applying it continuously.'

FG4 'There are many opportunities to apply the STEAM approach in kindergarten. I would be happy to implement it in collaboration with my colleagues.'

Participants expressed a willingness to apply the STEAM approach, with students from the natural sciences (FG2 and FG3) providing concrete examples of possible integrations into teaching practice. Pedagogy students (FG1) demonstrated greater enthusiasm than specific ideas, while students of fine arts and early childhood education recognised the potential of STEAM in creative and play-based contexts.

These findings highlight the need for further competence development and empowerment through training and mentorship.

5. *Academic Preparation* (reflection on the curriculum and the lack of practical training):
   - FG1 'We received some theoretical knowledge about STEAM, but not enough to feel competent.'
   - FG2 'I did not acquire sufficient knowledge about this area during my studies.'
   - FG3 'STEAM is insufficiently applied at university, although some lecturers incorporate certain elements of it.'
   - FG4 'We had methodology courses, but never anything specifically focused on STEAM.'

   All focus groups demonstrated an awareness of the limited presence of the STEAM approach within their study programmes. Although some theoretical foundations were mentioned, there is a clear lack of practical training that would equip students to implement STEAM in learning activities and classroom practice. This points to the need for curriculum reform aimed at greater integration of STEAM content and experiential learning.

6. *Support, Educational Context, and Suggestions* (proposals for training, mentoring, and institutional backing):
   - FG1 'I believe the curriculum should be more flexible.'
   - FG2 'What would be most useful for me is to attend training sessions, to observe how others implement it and draw ideas from their practice.'
   - FG2 'I think this approach could already be used during the revision phase, presenting the material in a different way and linking it to other subjects and fields.'
   - FG3 'The STEAM approach should be applied in education wherever possible, depending on the topic and the actual conditions.'
   - FG3 'More training and support are needed for teachers.'
   - FG3 'Organising professional seminars on this topic would help many preschool educators to apply the STEAM approach in their work with young children.'
   - FG5 'I believe it is necessary for all of us to attend training sessions where we can gain a deeper understanding of this approach.'

   Participants emphasised the need for institutional support, training, mentorship, and more flexible curricula that would enable the imple-

mentation of the STEAM approach. Particular importance was placed on professional seminars, demonstration lessons, and the exchange of practical experiences, creating opportunities to strengthen the capacities of educators and teachers.

7. *General Attitude – Conclusion* (summary assessment: willingness to implement, recommend, and belief in the approach's potential):
   - FG1 'I believe this is the future of education – we just need more support.'
   - FG1 'I would certainly promote this approach in the institution where I will be working.'
   - FG2 'This approach is valuable as it enables a problem to be viewed from multiple perspectives, which is lacking in today's school system.'
   - FG2 'It would be quite a laborious task to fully align everything with the STEAM model.'
   - FG3 'STEAM could have a positive impact on student motivation, but it requires greater effort from the teacher.'
   - FG3 'I would gladly recommend the introduction of this practice to my colleagues, although its success would certainly depend on their motivation and creativity.'
   - FG5 'I would recommend this approach to colleagues, as it allows us to work in an unconventional way and fosters stronger connections with other staff members.'

   Participants expressed a predominantly positive attitude towards the STEAM approach, accompanied by strong enthusiasm for its future application. However, they also recognised the need for additional support, training, and systemic solutions to ensure its sustainable and effective implementation. While participants would recommend the STEAM approach to their colleagues, they emphasised that its success depends on the motivation and professional competence of educators and teachers.

The results of the thematic analysis reveal diverse yet interrelated insights into the awareness, attitudes, challenges, and perceived applicability of the STEAM approach among prospective educators and teachers. The first thematic area, which pertains to awareness and understanding of the STEAM concept, highlights significant variability among participants. Although pedagogy students (FG1) demonstrated a slightly higher level of

familiarity with the basic principles of the concept, their understanding remains fragmented and is often limited to individual lectures. Students from other groups generally encountered the term STEAM for the first time outside of formal education-through extracurricular activities, posters, or informal sources. This supports the findings of Herro and Quigley (2017) and He et al. (2022), who emphasise that the lack of systematic education about STEAM hinders its comprehension and implementation.

Regarding attitudes and perceptions, the results indicate a distinctly positive affective response among students towards the STEAM approach. In all focus groups, STEAM was perceived as an innovative methodology, closely aligned with children's interests, and one that fosters curiosity, motivation, creativity, and hands-on learning. Participants also recognised that STEAM encourages the connection between theoretical knowledge and real-life situations, thus meeting the demands of contemporary education for sustainable development.

However, when analysing challenges related to the implementation of STEAM, a clear discrepancy emerges between students' enthusiasm and their assessment of the practical feasibility of implementation. Students identified several obstacles: a lack of equipment, time constraints, rigid curricula, and insufficient transdisciplinary knowledge. A sense of insecurity in team-based work and in implementing transdisciplinary content was also noted, confirming findings by Kartini and Widodo (2020) and Carter et al. (2021) regarding the limitations of institutional support and the complexity of integrated teaching approaches in real classroom conditions.

In terms of perceived applicability, participants expressed willingness and intent to implement STEAM in their future work, although the level of specificity in their proposals varied. Science students (FG2, FG3) exhibited the highest level of operationalisation, providing concrete examples of topics where STEAM could be integrated (e. g. photosynthesis, wastewater, chemical reactions). Participants from pedagogy and early childhood education (FG1, FG4) emphasised the importance of STEAM in promoting playful learning and early interest stimulation, although they offered fewer specific implementation scenarios. These findings align with Nørgaard et al. (2022), who note that prospective teachers are generally receptive to active and project-based learning methods, yet often require further competence development to implement them effectively.

Our research results also indicate a lack of formal education regarding the STEAM approach. Students were aware that they possessed only partial theoretical knowledge and lacked practical training that would enable

them to apply STEAM confidently in educational contexts. This is particularly concerning, as it prolongs the gap between positive attitudes and actual readiness for implementation-a gap also noted by Meneses et al. (2023) and Singh et al. (2024). Furthermore, the absence of methodological structuring of STEAM content in study programmes contributes to confusion regarding the role of the arts within the concept, as highlighted in the systematic review by Yulianti et al. (2024).

Support and systemic conditions are perceived as key factors for the successful integration of the STEAM approach. Participants expressed the need for further training, seminars, demonstration lessons, and mentoring by experts. There was also an emphasis on the necessity for more flexible curricula that would allow content integration and collaboration between teachers of different subjects. These findings correspond directly with the conclusions of Carter et al. (2021) and Sánchez Milara and Cortés Orduña (2024), who point to institutional barriers and the need for clearly defined educational models within the STEAM framework. However, it is important to note that content integration is considerably more feasible in early childhood education due to the greater autonomy of educators in planning activities and the flexibility of the curriculum.

Finally, participants' overall attitude towards STEAM can be described as a combination of enthusiasm, constructive critique, and realistic assessment of challenges. Although STEAM is recognised as a potential 'future of education,' its successful implementation depends on institutional support, training, resources, and the pedagogical empowerment of teachers and educators. These findings reinforce the need for systematic integration of STEAM into teacher education, in order to bridge the gap between theory and practice and to establish a foundation for sustainable educational practices aligned with the principles of education for sustainable development.

Conclusion

The analysis of focus group responses revealed that, despite limited awareness of the STEAM approach, students from various academic backgrounds demonstrated a high level of interest and positive attitudes towards its application in education and upbringing. Participants recognised numerous benefits of the STEAM approach, particularly in fostering creativity, motivation, and active learning, while also highlighting obstacles such as a lack of resources, practical training, and institutional support. The implementation of STEAM methodology in educational practice is perceived as challenging but achievable with appropriate training and mentoring. A pronounced need

was observed for greater integration of the STEAM concept into higher education curricula, especially through practical, transdisciplinary, and experiential forms of teaching. Students from different study programmes display varying levels of preparedness and competence for its application, which further underscores the necessity for a systematic approach to training future educators in this field. Through a transdisciplinary approach, the development of critical thinking, the application of sustainable technologies, artistic expression, and collaboration, students not only acquire academic knowledge but also become responsible, creative, and innovative problem-solvers capable of contributing to the sustainable development of society. Future teacher education programmes should incorporate structured modules on STEAM pedagogy, tailored to the specific needs of different academic disciplines. Integrating STEAM principles into the curriculum can help bridge the gap between theory and practice, equipping pre-service teachers with the necessary skills to implement transdisciplinary and experiential learning strategies. Moreover, by fostering curiosity, adaptability, and reflective practice, such curricula can better prepare pre-service educators for lifelong learning and continuous professional development. Embedding STEAM into higher education not only enhances their immediate teaching competence but also cultivates the mindset needed to navigate and contribute to evolving educational landscapes.

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Izobraževanje STEAM za inovativen pristop k trajnostnemu razvoju: perspektive bodočih vzgojiteljev predšolskih otrok in učiteljev

Sodobno izobraževanje je vse pogosteje obravnavano skozi prizmo trajnostnega razvoja, s poudarkom na pedagoških praksah, ki spodbujajo razvoj kompetentnih, ustvarjalnih in družbeno odgovornih posameznikov. Pristop STEAM (iz angl. *Science, Technology, Engineering, Arts, Mathematics;* znanost,

tehnologija, inženirstvo, umetnost in matematika) je prepoznan kot inovativna metodologija, ki povezuje različna področja ter pri otrocih in učencih spodbuja transdisciplinarno razmišljanje, reševanje problemov, ustvarjalnost in kritično mišljenje. Ta pristop neposredno prispeva k izobraževanju za trajnostni razvoj z izboljševanjem kakovosti izobraževanja in s spodbujanjem enakosti spolov ter inovativnosti. Namen tega prispevka je raziskati ozaveščenost študentov pedagoških študijskih programov o izobraževanju STEAM, njihova stališča o njegovi uporabnosti ter pripravljenost za implementacijo v bodoči poklicni praksi. Kvalitativna raziskava je bila izvedena z uporabo fokusnih skupin s študenti različnih pedagoških smeri (naravoslovje, družboslovje in umetnost). Analizirana so bila stališča študentov, identificirane pa so bile tudi zaznane prednosti, ovire in potrebe po dodatni podpori pri uvajanju pristopa STEAM. Rezultati kažejo na omejeno formalno izobraževanje o STEAM-u, vendar tudi na močno motivacijo študentov za njegovo uporabo, zlasti v kontekstih, ki spodbujajo inovativnost, inkluzijo in povezovanje teoretičnega znanja z življenjskimi situacijami. Kot ključni izzivi so bili prepoznani pomanjkanje praktičnega usposabljanja, nezadostna institucionalna podpora in omejeni viri. Udeleženci so poudarili potrebo po večji integraciji vsebin, povezanih s STEAM-om, v visokošolske kurikulume. Zaključne ugotovitve poudarjajo nujnost sistemske integracije izobraževanja STEAM v programe usposabljanja učiteljev in vzgojiteljev predšolskih otrok kot ključni dejavnik za razvoj trajnostnih izobraževalnih praks. Podpora bodočim pedagogom pri pridobivanju kompetenc za transdisciplinarno učenje in inovativno poučevanje je lahko odločilna za napredek izobraževanja za trajnostni razvoj.

Ključne besede: izobraževanje STEAM, izobraževanje za trajnostni razvoj, inovativne pedagoške prakse, ustvarjalnost, kritično mišljenje, transdisciplinarnost