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A Systematic Review on Interdisciplinary STEM: Integration of Humanities, Arts, and Social Scientific Issues in Science Learning

Budiman[1], Irma Rahma Suwarma[1,*], Akbar Aba[2] & Hendri Irawan[3]

[1]Department of Science Education, Universitas Pendidikan Indonesia, Indonesia

[2]Department of Pancasila and Citizenship Education, Universitas Muhammadiyah Makassar, Indonesia

[3]Department Civic Education, Universitas Pendidikan Indonesia, Indonesia

Abstract: The aim is to understand the application and impact of STEM Humanities in science education as an implementation reference. This review systematically explores papers published between 2018-2022 through keyword searches and a snowballing approach on the Scopus database; 16 journal papers were included. The analysis shows that Implementation of Interdisciplinary STEM (STEM Humanities), Interdisciplinary Potential of STEM (Students' perceptions of the relationship between science and non-science), Impact of Interdisciplinary STEM (STEM Humanities). The collective findings of 16 papers show that STEM interdisciplinarity opportunities to combine learning between science and non-science. Allows students to understand problems that exist in the real world. By grasping real-world issues, students can enhance their problem-solving skills, aligning with the demands of the 21st century. Moreover, interdisciplinary STEM ensures that students with disabilities and people of colour feel comfortable in their learning environment, preventing discrimination against students from diverse backgrounds.

Keywords: interdisciplinary stem; stem humanities; problem-solving

Abstrak: *Artikel ini mengeksplorasi temuan terkait interdisipliner STEM dengan fokus integrasi Humaniora, Seni, dan Sosial Sains (STEM Humanistik). Tujuannya adalah untuk memahami penerapan dan dampak Humanistik STEAM dalam pendidikan sains sebagai referensi implementasi. Tinjauan ini secara sistematis mengeksplorasi makalah yang diterbitkan antara tahun 2018 dan 2022 melalui pencarian kata kunci dan pendekatan snowballing pada database Scopus; 16 makalah jurnal dimasukkan dalam ulasan ini. Analisis menunjukkan bahwa Implementasi Interdisipliner STEM (STEM Humanistik) Potensi Interdisipliner STEM (Persepsi siswa pada hubungan antara sains dan non sains) Dampak Interdisipliner STEM (STEM Humanistik). Temuan kolektif dari 16 makalah menunjukkan bahwa interdisipliner STEM membuka peluang untuk menggabungkan pembelajaran antara sains dengan non sains. Hal tersebut, dapat membuat peserta didik memahami masalah yang ada di dunia nyata. Dengan memahami masalah dunia nyata, peserta didik dapat meningkatkan keterampilan pemecahan masalah yang sesuai dengan keterampilan tuntutan abad 21. Selain itu, interdisipliner STEM memberikan kenyamanan peserta didik disabilitas dan kulit berwarna dalam belajar sehingga tidak terdapat deskriminasi pada siswa dengan latar belakang yang berbeda.*

Kata kunci: *kemampuan berpikir kreatif matematis, means-ends analysis, pendekatan realistik, kemandirian belajar siswa*

▪ INTRODUCTION

STEM (Science, Technology, Engineering, and Mathematics) education is not only limited to scientific disciplines but also includes non-science disciplines. This is the Interdisciplinary STEM approach (Faulconer et al., 2020; Leyva et al., 2022; Marcone, 2022; Melton et al., 2022; Tsinajinie et al., 2021). STEM interdisciplinary opens

Irma Rahma Suwarma
*Email: irma.rs@upi.edu

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opportunities to combine other scientific disciplines into science (Faulconer et al., 2020). Interdisciplinary STEM aims to prepare students to face and solve problems that exist in the real world (Herro et al., 2019; Macalalag et al., 2020; Melton et al., 2022; Quigley et al., 2017; Quigley et al., 2020; Reynante et al., 2020; Tsinajinie et al., 2021). One of the multidisciplinary practices of STEM is the integration of humanities, arts, and social sciences in learning, which is called STEM Humanities (Leyva et al., 2022; Macalalag et al., 2020; Marcone, 2022; Melton et al., 2022; Tabarés & Boni, 2022). STEM Humanities focuses on problems around students, so it does not only focus on understanding concepts but also focuses on students' concern for their social environment, which is relevant to learning content (Chang & Chang-Tzeng, 2020; Marcone, 2022; Melton et al., 2022; Shifrer & Freeman, 2021; Tabarés & Boni, 2022; Tsang, 2019).

In an increasingly complex world, education must adapt to today's challenges (Alam, 2021; Brunetti et al., 2020; Hynes et al., 2020; Simamora et al., 2018; Simamora, 2020). Education must deepen knowledge in a specific field and teach students to see and understand a broader perspective (Falloon, 2020). In line with Interdisciplinary STEM and STEM Humanities, education today must prioritize collaboration between various scientific disciplines (Belbase et al., 2022; Mpofu et al., 2019; Yamada, 2021). This way, students can understand the relationship between science and other arts, social sciences, and humanities fields. This collaboration will help students think critically, solve problems, and understand the impact of science on everyday life (Mukaromah et al., 2022; Zayyinah et al., 2022).

Although STEM Humanities education offers an innovative learning approach and is relevant to today's needs, its implementation still faces several challenges (Belbase et al., 2022; Herro et al., 2019). One of the main problems is the rigid and segmented curriculum in many educational institutions (Herro et al., 2019; Quigley et al., 2017; Yamada, 2021; Yang, 2022; Yang et al., 2022). This makes it difficult to integrate across disciplines, which is the essence of STEM Humanities-based education. In addition, a lack of understanding and training for educators regarding the concepts and methods of interdisciplinary learning is a significant barrier (Borda et al., 2020; Margot & Kettler, 2019). Without adequate support and a proper understanding of this approach, it won't be easy to implement it effectively in the classroom setting. To optimize the benefits of this interdisciplinary approach, there is an urgent need to revise the curriculum and increase teacher capacity in its implementation.

Therefore, this article will discuss and explore the interrelated findings or research in interdisciplinary STEM limited to integrating Humanities, Arts, and Social Sciences in STEM learning (STEM Humanities). This research also explores how STEM Humanities is implemented and its impact on education and learning. This can be used as a reference for implementing interdisciplinary STEM into learning, especially science learning. The research questions in this article are as follows: How does the interdisciplinary approach to STEM prepare students to understand the real world? How does interdisciplinary STEM shape students' problem-solving abilities? What are students' perceptions of the connection between science and non-science? How does STEM Humanities impact student comfort, content mastery, and learning outcomes?

▪ METHOD

We adhered to the proposed three-stage framework for a thorough and reliable systematic literature review (Tranfield et al., 2003). This guideline consists of the following stages: Stage I includes the review planning stage, Stage II covers the collection of relevant literature, and Stage III focuses on reporting and disseminating findings. During Phase II, we used a snowballing technique to identify and select articles related to our discussion. Relevant articles were searched in leading databases such as Scopus, MDPI, Elsevier, Emerald, ScienceDirect, Springer, and Taylor & Francis.

Article Selection Procedure

Article searches were conducted in the first half of October 2022 on Scopus databases such as MDPI, Elsevier, Emerald, ScienceDirect, Springer, and Taylor & Francais. The search was limited to 2018-2023. Keywords used in search engines include "HUMANITIES" and "INTERDISCIPLINARY and STEM." The following are the criteria (Figure 1) that can be included in article selection: (1) We focus on collecting journal articles indexed by Scopus from the first and second quartiles (Q1-Q2) based on Scimago Journal Rankings, (2) Our search included articles containing the terms "STEM," "Interdisciplinary," and "Humanities" in either the title, abstract, or keywords, (3) The selected articles cover educational institutions implemented in formal and non-formal educational environments, particularly emphasizing interdisciplinary STEM, especially integrating humanities, arts, and social sciences in learning, and (4) This article presents the findings and summarizes the impact of interdisciplinary STEM, especially the integration of humanities, arts, and social sciences.

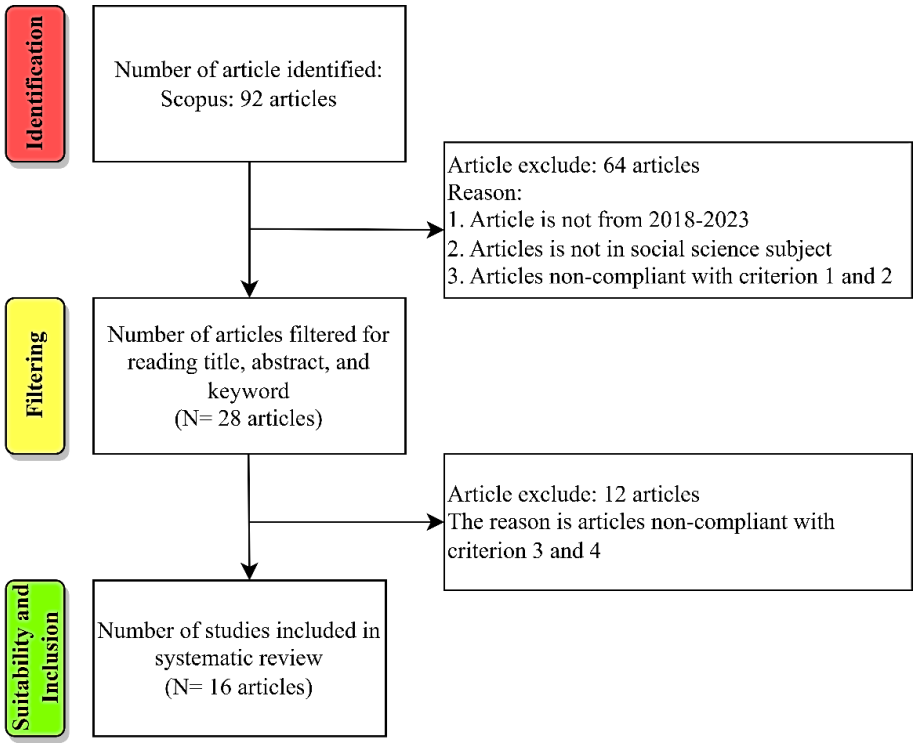

Figure 1. Flowchart of article selection procedures

Data Extraction Procedure

The data we took for analysis was based on the following units of study: 1) Implementation of Interdisciplinary STEM (STEM Humanities), 2) Interdisciplinary Potential of STEM (Student perceptions of the relationship between science and non-science, and 3) Impact of Interdisciplinary STEM (STEM Humanities). Table 1 illustrates the relevant sections of the document relating to each unit of analysis, along with examples of the coding used.

Table 1. Description of unit analysis

Unit of Analysis	Section under Analysis	Coding
Interdisciplinary Implementation of STEM (STEM Humanities)	Theoretical Framework Discussion	- *Specific - Non Specific
STEM Interdisciplinary Potential (Students' perceptions of the relationship between science and non-science)	Discussion and Conclusions	- *Positive - Negative - No Effect
Interdisciplinary Impact of STEM (STEM Humanities)	Discussion and Conclusions	- *Positive - Negative - No Effect

▪ RESULT AND DISSCUSSION

Table 2 shows the main characteristics of the 16 studies on educational interventions included in the systematic review: author and year of publication, country, academic stage at which each educational intervention was designed, research methods, and quartiles.The results of the study are presented in the form of graphs, tables, or descriptive.

Table 2. Article findings

Author	Years	Country	Educational Stage	Method	Quartiles
Faulconer et al.	2020	USA	Universitas	Quantitative	Q1
Marcone	2022	Peru	Universitas	Case Study	Q2
Herrenkohl	2019	World	middle school, high school, and university	Case Study	Q1
Reynate et al.	2020	USA	School	Qualitative	Q1
Herro et al.	2019	USA	Middle school	Qualitative	Q2
Chang & Chang-Tzeng	2020	Taiwan	Ministry of Education	Quantitative	Q1
Roothooft	2022	Spain	University	Mix Method	Q1
Tabares & Boni	2022	Spain	University	Case Study	Q1
Macalalag	2020	USA and Italian	Middle school	Case Study	Q1
Tsang	2019	USA	Universitas	Quantitative	Q1
Quigley	2020	USA	Elementary School	Qualitative	Q1
Shifrer & Freeman	2021	USA	High School	Quantitative	Q1
Leyve et al.	2022	USA	University	Qualitative	Q1

Tsinajinie et al.	2021	USA	middle-school and high-school	Qualitative	Q1
Lee	2022	USA	Universitas	Quantitative	Q2
Melton et al.	2022	Taiwan	Universitas	Case Study	Q1

The comprehensive systematic literature review included articles published between 2018-2022. These articles were selected based on specific inclusion criteria, focusing on international journals indexed by Scopus and categorized as Q1 and Q2. In this discussion, we focus on answering research questions: (1) How does the interdisciplinary STEM approach prepare students to understand the real world? (2) How does interdisciplinary STEM shape students' problem-solving abilities? (3) What are students' perceptions and understanding of the connection between science and non-science? (4) How does STEM Humanities impact student comfort, mastery of content, and learning outcomes?

An Interdisciplinary Approach To STEM Education Better Prepares Students To Understand The Natural World Around Them.

The interdisciplinary STEM approach, in this case, integrates other scientific disciplines into science disciplines (Herro et al., 2019; Quigley et al., 2017) and has a vital role in encouraging student participation in practice and work to discover and understand real-world problems (Leyva et al., 2022; Macalalag et al., 2020; Marcone, 2022; Melton et al., 2022; Tabarés & Boni, 2022; Tsinajinie et al., 2021). In the course, the relationship between science and society is studied and grouped based on experience through an interdisciplinary approach (Melton et al., 2022) so that students can understand how learning refers to real-world problems that are relevant to learning (Herro et al., 2019; Leyva et al., 2022; Macalalag et al., 2020; Marcone, 2022; Quigley et al., 2020; Tabarés & Boni, 2022). Learning using an interdisciplinary STEM approach provides positive impacts that are relevant to the real world so that it can prepare students to focus (Tabarés & Boni, 2022; Tsinajinie et al., 2021) and understand the natural world around them (Faulconer et al., 2020; Marcone, 2022; Tsinajinie et al., 2021).

This integration of humanities in STEM education is called STEM Humanities (Faulconer et al., 2020). STEM Humanities combines STEM with an interest in caring for humanitarian affairs (Tsinajinie et al., 2021), welfare (Leyva et al., 2022), culture (Faulconer et al., 2020; Tabarés & Boni, 2022), and social issues that exist in the real world (Macalalag et al., 2020; Marcone, 2022). In practice, learning with a STEM Humanities approach directs students to think about things that happen to the world around them and then associate them with STEM learning (Macalalag et al., 2020; Melton et al., 2022; Tabarés & Boni, 2022) so that with this learning, students can understand and be aware of the relationship between STEM and the world around them (Faulconer et al., 2020; Marcone, 2022; Melton et al., 2022; Tabarés & Boni, 2022).

Activities carried out by providing cases about the environment in STEM learning with a world-around approach and providing knowledge and experience about social issues benefitting students' environmental awareness (Macalalag et al., 2020). Apart from that, learning activities by making students observe (Leyva et al., 2022; Macalalag et al., 2020) and explore the environment, such as trees and moss, also provide benefits in increasing environmental awareness (Tsinajinie et al., 2021). With that, STEM education

can direct students to focus on humans and nature (Macalalag et al., 2020; Tabarés & Boni, 2022).

STEM learning activities with real-world approaches, such as demonstrating economic, political, social, and technological where students identify problems and design solutions to these problems, make students more aware of the relationship between global challenges and social development goals with local realities and students' life experiences (Marcone, 2022; Melton et al., 2022). In addition, STEAM learning activities, by providing comparisons of design and applicable practices of principles (problem-based, discipline integration, authentic tasks, and student choice), can help students consider how these problems impact students' lives and the natural world (Herro et al., 2019; Quigley et al., 2020). These activities, guided by teacher instructions in implementing STEAM, thus make students focus on real-world problems aligned with learning content (Herro et al., 2019).

Apart from integrating humanities disciplines into STEM learning, an interdisciplinary approach can be carried out by integrating Social Science Issues (SSI) into education. In learning activities incorporating SSI, students are directed to think about social issues that occur, such as being led to study the challenges in various countries regarding getting food (Macalalag et al., 2020), which can make students understand more about the natural world (Marcone, 2022).

Teachers who allow students to direct learning and provide opportunities to think about problems in the surrounding environment and opportunities to create authentic assignments in STEM learning (Quigley et al., 2020), with these activities, students learn on their own. They can start studying the parts they need. Different from real-world problems, it can provide extensive real-world experience on issues relevant to STEM learning (Melton et al., 2022).

STEM Interdisciplinary Can Shape Students' Problem-Solving Abilities

STEM education with an interdisciplinary approach emphasizes integrating technology and engineering principles, such as design processes, to enhance innovation and problem-solving; this is an essential aspect of solving real-world problems in STEM education (Marcone, 2022; Reynante et al., 2020). Interdisciplinary STEM also includes a lot of content that encourages different ways of problem-solving (Quigley et al., 2020), such as humanities content (Faulconer et al., 2020; Herrenkohl et al., 2019; Herro et al., 2019; Marcone, 2022) and social (Marcone, 2022; Melton et al., 2022; Shifrer & Freeman, 2021; Tabarés & Boni, 2022). With that, interdisciplinary STEM is precisely oriented towards how to discover (Herrenkohl et al., 2019) and solve problems that exist in the world around (Melton et al., 2022; Reynante et al., 2020) such as environmental problems (Macalalag et al., 2020), social (Melton et al., 2022) culture (Tabarés & Boni, 2022), and life around students (Faulconer et al., 2020). In addition, students' abilities in problem-solving have the potential to help find ways and solutions to the real world (Melton et al., 2022) so that students can witness how diverse knowledge and experiences contribute to solving problems concerning STEM (Herrenkohl et al., 2019).

One of the interdisciplinary STEM practices in learning is the integration of Humanities, Art, and Social Science (HASS) (Faulconer et al., 2020; Herro et al., 2019; Marcone, 2022; Melton et al., 2022). This is a central problem-solving approach (Herro et al., 2019; Melton et al., 2022). Activities carried out in learning specifically include the

teacher including activities that help students consider the problems given have an impact on students' lives (Quigley et al., 2020), quoting several sayings from philosophers to be used at the end of learning (Faulconer et al., 2020) giving understanding the relationship between science and everyday human life (Marcone, 2022; Reynante et al., 2020), students are depicted as leaders when they carry out problem-solving (Tsinajinie et al., 2021), directing to use each student's expertise (Herrenkohl et al., 2019), providing collaborative activities to solve problems in a naturally connected way that is related to the content (Herro et al., 2019) can make students discover new ways of solving problems, especially those in the real world and the world around (Macalalag et al., 2020; Marcone, 2022; Quigley et al., 2020; Tsinajinie et al., 2021).

In reflection activities about the evolution of the relationship between technology and society, presenting global issues such as health, education, poverty (Marcone, 2022), observing nature (Macalalag et al., 2020), exploring (Tsinajinie et al., 2021), and describing events Earth's environmental problems in the classroom (Macalalag et al., 2020) can make students more aware of ecological problems that exist in the real world (Herro et al., 2019; Macalalag et al., 2020; Marcone, 2022; Tsinajinie et al., 2021).

The learning practices carried out in integrating HASS in STEM learning (Macalalag et al., 2020; Marcone, 2022), where the activities carried out involve personal dimensions (Herrenkohl et al., 2019) and focus on ethical scientific practices (Macalalag et al., 2020; Reynante et al., 2020) to develop students' sensitivity to moral and ethical aspects in the development of science and technology can address moral and ethical issues that are relevant to students (Macalalag et al., 2020; Marcone, 2022). By demonstrating the need for education to engage in community information-seeking and community empowerment to take responsibility for sustainable development challenges, understanding professional and ethical responsibilities (Marcone, 2022), social responsibility (Macalalag et al., 2020; Melton et al., 2022), and being responsible for information and the complexity of education in using technology (Marcone, 2022) can teach students to be accountable in solving real-world problems (Macalalag et al., 2020; Melton et al., 2022).

Activities carried out by teachers in providing a problem-based classroom environment that refers to social science teaching that is relevant to society and students' lives (Macalalag et al., 2020), which is based on student priorities such as knowledge (Quigley et al., 2020), experience (Tsinajinie et al., 2021), student's background and culture have a positive effect on students' understanding of problem-solving. In addition, problems that are connected to students' lives are significant to promote problem-based learning practices that are relevant to learning (Macalalag et al., 2020) so that students understand how to solve problems in real-world life (Macalalag et al., 2020; Melton et al., 2022; Quigley et al., 2020; Tsinajinie et al., 2021).

Studying problems effectively can be done by building students' self-confidence, where in practice, the teacher directs students to relate the material to things that students care about, using visual aids (students with disabilities) (Shifrer & Freeman, 2021; Tsinajinie et al., 2021), discussing (Melton et al., 2022), and collaborating can enable students to learn to solve problems effectively, especially those in the environment and the natural world around students (Melton et al., 2022; Shifrer & Freeman, 2021; Tsinajinie et al., 2021). STEM Humanities-based learning with student-centered learning can foster critical thinking skills to identify and solve problems, especially solutions and

climate change problems in the real world (Melton et al., 2022; Tabarés & Boni, 2022). In addition, learning activities designed to focus on developing critical thinking can create and shape students' problem-solving in facing social challenges (Tabarés & Boni, 2022).

STEM Humanities Provides A Perception And Understanding Of How Science And Non-Science Are Connected.

In STEM Humanities practices, where teachers use a humanities disciplinary approach (Faulconer et al., 2020; Herrenkohl et al., 2019; Marcone, 2022; Reynante et al., 2020), social (Chang & Chang-Tzeng, 2020; Macalalag et al., 2020; Melton et al., 2022; Shifrer & Freeman, 2021; Tsinajinie et al., 2021), culture (Tabarés & Boni, 2022), and philosophy (Melton et al., 2022; Roothooft, 2022) to in learning can make students understand how science makes connections with non-science disciplines (Faulconer et al., 2020; Macalalag et al., 2020; Shifrer & Freeman, 2021) so that learning with a STEM Humanities approach can provide perception and understanding to students about how science and non-science are connected (Faulconer et al., 2020; Herrenkohl et al., 2019; Macalalag et al., 2020; Marcone, 2022; Melton et al., 2022; Roothooft, 2022; Shifrer & Freeman, 2021). In addition, perceptions and understanding of how science and non-science are connected can not only be understood by students but also by teachers, STEM practitioners, and policymakers so that, in general, STEM can be seen and assessed not only as coming from science but also found in non-science disciplines (Macalalag et al., 2020; Melton et al., 2022; Reynante et al., 2020; Roothooft, 2022; Tabarés & Boni, 2022; Tsinajinie et al., 2021).

STEM Humanities practices use a social issues approach to learning, such as integrating gender equality issues (Chang & Chang-Tzeng, 2020; Shifrer & Freeman, 2021) sustainable development challenges (Marcone, 2022; Melton et al., 2022), economics (Reynante et al., 2020), ethics and morals (Marcone, 2022; Melton et al., 2022), global issues (Chang & Chang-Tzeng, 2020; Marcone, 2022), culture (Tabarés & Boni, 2022), and humanity (Melton et al., 2022) can draw connections between science and non-science so that teachers and students can understand how science is connected to other scientific discipline programs (Faulconer et al., 2020). In cultural practices related to science, in this case, it is making students think about things in the world around them (Macalalag et al., 2020; Tabarés & Boni, 2022) such as students' cultural backgrounds, and then connecting them with science learning can make students understand the relationship between science and non-science (Herrenkohl et al., 2019; Shifrer & Freeman, 2021; Tabarés & Boni, 2022). Apart from students understanding how the connections between sciences relate, teachers have the opportunity to understand and learn about the unknown cultures that students come from.

The value of openness and collaboration in obtaining knowledge, especially in STEM education (Melton et al., 2022), in this case, the acquisition of knowledge about how to help society or students face the significant challenges they face (Tsinajinie et al., 2021), as well as identifying problems and designing solutions to climate change or air pollution (Melton et al., 2022) can make students understand how science and non-science are connected (Melton et al., 2022; Tabarés & Boni, 2022; Tsinajinie et al., 2021). Terminology, in this case, is the use of terms and language concerning exploring and recognizing social science issues in STEM education (Roothooft, 2022). In practice, teachers use a terminology approach related to climate change, and then students are

directed to look for and investigate solutions to this issue (Melton et al., 2022); this can make students understand how science is connected to non-science so that students' perceptions can be expanded on STEM education through a terminology approach, especially concerning social issues (Melton et al., 2022; Roothooft, 2022).

Integrating Humanities In STEM Education Makes Students Feel Comfortable And Heard In Their Learning.

The integration of humanities in STEM education focuses on learning real-world approaches (Shifrer & Freeman, 2021; Tsang, 2019; Tsinajinie et al., 2021), the surrounding environment (Lee, 2022), and concern for humanitarian affairs (Chang & Chang-Tzeng, 2020; Herrenkohl et al., 2019; Leyva et al., 2022). In practice, the activities carried out in learning are oriented towards forming students' perceptions and thinking (Leyva et al., 2022; Tsang, 2019) and encouraging students to ask questions (Tsinajinie et al., 2021). So that with this learning, students will feel comfortable and heard in learning (Herrenkohl et al., 2019; Lee, 2022; Shifrer & Freeman, 2021; Tsang, 2019; Tsinajinie et al., 2021).

Apart from providing comfort to students in learning, STEM also creates a comfortable learning atmosphere for students with disabilities. This is produced by collaborative activities (Tsinajinie et al., 2021), giving motivation, increasing the use of technology in learning (Lee, 2022), and making students with disabilities more involved in education. In addition, providing opportunities for students to respond and deliver perceptions about learning (Leyva et al., 2022) can also make students with disabilities comfortable in learning (Lee, 2022; Shifrer & Freeman, 2021; Tsinajinie et al., 2021).

The practice of expanding the system, in this case, gives students the freedom to choose programs according to their wishes in choosing humanities or STEM programs in their degree program; this can provide comfort for students in studying (Lee, 2022), especially for women in STEM programs (Chang & Chang-Tzeng, 2020) so that perceptions about the importance of gender equality patterns can be applied to STEM and Humanities education (Chang & Chang-Tzeng, 2020; Tsang, 2019).

Integrating the humanities into STEM learning centers students' educational needs and interests, thereby providing the best STEM learning experiences for young people of color, immigrants, and refugees (Herro et al., 2019). In addition, learning activities in STEM education seek to increase the value of solidarity in group learning to be utilized in reconciling individual differences, especially for whites and blacks (Leyva et al., 2022).

Implementasi STEM Humanities Positively Impacts Content Mastery And Student Learning Outcomes.

In STEM Humanities implementation activities where learning is carried out using an environmental approach (Macalalag et al., 2020; Melton et al., 2022; Quigley et al., 2020; Shifrer & Freeman, 2021; Tsinajinie et al., 2021), real-world (Quigley et al., 2020), humanity (Chang & Chang-Tzeng, 2020), culture and focusing on the students themselves (Tabarés & Boni, 2022), providing a positive impact on students' content mastery, because learning involves the surrounding life that exists in their lives. Students themselves (Quigley et al., 2020; Tsang, 2019) so that students can expand their knowledge of what they learn in STEM learning (Macalalag et al., 2020; Melton et al., 2022; Quigley et al., 2020; Tabarés & Boni, 2022; Tsinajinie et al., 2021). Apart from

that, integrating humanities in STEM learning does not hurt students' mastery of content, where students can still focus on original content in education (Faulconer et al., 2020).

STEM Humanities is oriented towards how students are involved in the learning process, not just the product, by directing students to see what is happening around them, such as the environment (Melton et al., 2022; Quigley et al., 2020; Tsinajinie et al., 2021), gender (Shifrer & Freeman, 2021; Tsang, 2019), social and cultural (Melton et al., 2022; Tabarés & Boni, 2022), to be connected with STEM learning as well as finding solutions for problem-solving from this approach, can make students more mastering content in education (Melton et al., 2022).

Apart from focusing on processes, not just products, students are also directed to discuss environmental (Tsinajinie et al., 2021), social, and cultural issues (Tabarés & Boni, 2022) collaboratively to identify and design solutions; this can make students understand and master learning content (Quigley et al., 2020). Collaborative activities also benefit students with physical disabilities so that not only regular students can master learning content but also students who experience physical limitations in learning (Tsinajinie et al., 2021).

Activities carried out to stimulate student motivation in STEM Humanities learning are teachers applying quotes from philosophers related to science to be used at the end of education (Faulconer et al., 2020); apart from that, the practice carried out is providing problem-solving motivation to students to understand more about the natural world around them, such as the environment and humanity (Macalalag et al., 2020; Tabarés & Boni, 2022). This positively impacts students' mastery of content because it can draw connections between STEM learning and things around them (Shifrer & Freeman, 2021). Thus, learning content can be mastered effectively because it uses what is around students (Tsinajinie et al., 2021).

Of the several studies that have been carried out related to interdisciplinary STEM, in this case integrating humanities, arts, and social sciences, further research still needs to be carried out because there is still a need for development in terms of teaching materials, models, methods, and implementation stages. Apart from that, previous research only minimally integrated humanities, arts, and social sciences because, according to Faulconer et al. (Faulconer et al., 2020), there was fear of a negative impact on the original learning content. However, this integration cannot make students truly understand what is around them because the integration does not affect the students' personalities.

▪ CONCLUSION

This research concludes that interdisciplinary STEM opportunities combine learning between science and non-science. This can enable students to understand problems that exist in the real world. By understanding real-world issues, students can improve prob-lem-solving skills that align with the skills demands of the 21st century. In addition, in-terdisciplinary STEM provides students with disabilities and people of color comfort in learning so that there is no discrimination against students with different backgrounds. Therefore, it is essential to implement interdisciplinary STEM into education, both in sci-ence and non-science learning.

However, many researchers have not researched STEM Humanities, so further re-search is still needed regarding implementation, development, methods, models, and ap-

proaches to STEM Humanities. So, the following research recommendation focuses on developing STEM Humanities-based learning to improve students' problem-solving skills and awareness of the environment around them.

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