education sciences

MDPI

Article

Exploring the Golden Ratio in Nature by Using a STEAM Approach: A Diagnostic and Quasi-Experimental Study at a Senior University

Nuno Teles [1,2], Tiago Ribeiro [1,3] and Clara Vasconcelos [1,3,*]

[1] Interdisciplinary Centre of Marine and Environmental Research (CIIMAR), University of Porto, 4450-208 Matosinhos, Portugal; ensantos@mhnc.up.pt (N.T.); tribeiro@fc.up.pt (T.R.)
[2] Natural History and Science Museum of the University of Porto (MHNC-UP), University of Porto, 4050-368 Porto, Portugal
[3] Science Education Unit, Faculty of Sciences of University of Porto (FCUP), University of Porto, 4169-007 Porto, Portugal
* Correspondence: csvascon@fc.up.pt

Abstract: This research addresses the social exclusion of elderly citizens in terms of lifelong education via an interdisciplinary STEAM (science, technology, engineering, arts, and mathematics) approach. Technological literacy among older people is a critical factor in social exclusion. This study seeks to provide senior citizens with competencies in scientific, artistic, mathematical, and technological domains by enhancing scientific and technological literacy. The research developed a series of non-formal education sessions on the golden ratio using a STEAM educational approach. A quantitative methodology approach was carried out by using a diagnostic survey of the participants' conceptions and a subsequent quasi-experimental study to evaluate the impact of the intervention. This study, conducted with 37 senior citizens (n = 37), found positive results aligning with the existing literature on the potential of the STEAM approach. The STEAM approach proved to be engaging for seniors, offering a holistic and interdisciplinary educational experience. Despite the limited availability of science educational programs for seniors and the scarcity of studies on lifelong learning using the STEAM approach, this research highlights the need for such initiatives, especially given the growing senior population. Applying STEAM education shows promise in enhancing scientific literacy and motivation among adult learners. By integrating mathematical concepts, such as the golden ratio, with practical applications in arts and natural sciences, STEAM education can provide a rich, motivating, and accessible learning experience, promoting active and healthy ageing through lifelong learning. Further research and development in this area could maximise educational benefits for the senior population.

Keywords: golden ratio; lifelong education; non-formal education; STEAM education

check for updates

Citation: Teles, N.; Ribeiro, T.; Vasconcelos, C. Exploring the Golden Ratio in Nature by Using a STEAM Approach: A Diagnostic and Quasi-Experimental Study at a Senior University. *Educ. Sci.* **2024**, *14*, 705. https://doi.org/10.3390/educsci14070705

Academic Editor: Xinqiao Liu

Received: 6 June 2024
Revised: 25 June 2024
Accepted: 25 June 2024
Published: 28 June 2024

Copyright: © 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

In Europe, the trend of demographic ageing persists, as evidenced by shifting age pyramids. Simultaneously, an ageing population is frequently depicted as a challenge, given its strain on pension and healthcare systems [1–3]. Education and lifelong learning are commonly advocated as the remedy for issues stemming from shifts in our demographic profile. Lifelong education is seen as a way to extend working life and enhance well-being among the retired population [1,2]. Research has emphasised the connection between education and health, particularly in the context of older adults' learning. A relatively recent study, derived from longitudinal research spanning 44 years and focusing on dementia risk in women, has demonstrated the risk-reducing effects of cognitive and physical activities during midlife [4].

While the current demographic landscape presents new challenges, theories regarding older adults' learning have a longstanding history. For instance, geragogy emerged based on the notion that instructing older adults differs from teaching younger adults. Geragogy posits that learning should be centred on enjoyment and curiosity, prompting educators to foster learner engagement through positive reinforcement and encouragement [1,5,6]. It offers a framework of principles to guide educators in structuring courses, such as presenting course outcomes before instruction, utilising diverse teaching methodologies, embracing flexibility, considering learners' past experiences to ground understanding, maintaining topic clarity, and adjusting the course pace to learners' needs. However, geragogy has faced criticism since it promotes a top-down approach where educators are tasked with satisfying older adults' need for stimulation [5,6]. This approach is counterproductive because it views participants merely as education recipients rather than active knowledge creators [1]. While learning competency persists throughout life, how individuals engage in education or educational pursuits may change [7]. Nonetheless, the enduring interest many individuals demonstrate in education remains consistent. This is evident, for instance, in the expanding global network of senior universities [8], aiming to promote well-being and address challenges related to gender, social class, ageism, and ethnic biases [1,9]. In addition to ethnic and gender biases, ageism stands out as one of the most prevalent and detrimental forms of prejudice, particularly in an era characterised by a rapidly ageing society [10]. In order to optimise learning benefits for senior citizens, greater attention to learners' physiological constraints is essential. Additionally, there needs to be a dedication to freeing older individuals from ageist systems within education and broader society while empowering them to address and dismantle ageism [6].

Developing a society based on inclusion and democracy requires integrating seniors in decision-making from a participatory perspective. This concern is present in various documents, such as the United Nations' 2030 Agenda for Sustainable Development. In the particular case of education, the fourth goal (SDG4) clearly advocates for inclusion through lifelong education—"*Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*" [11], p. 19. Due to internalised ageist beliefs, educators must adopt a proactive approach to dispel age-related stereotypes and strengthen (lifelong) learners' confidence before fostering greater independence in their learning. This entails promoting positive attitudes toward ageing and integrating opportunities for reflection on age-related challenges as integral components of lifelong learning design [6]. A specific study revealed a notable correlation between higher educational attainment and reduced levels of ageism. This finding aligns with cross-cultural research, indicating that more educated societies tend to exhibit fewer negative attitudes toward older individuals [12]. Nevertheless, given that our current society is not solely focused on age but also functionality, efforts to de-prioritise age in policies may pose challenges for individuals with illnesses and disabilities. Even if the intention is to shift from age-based categorizations to prioritising individual needs among all citizens equally, functional capability emerges as a crucial consideration when age loses significance [13].

In today's rapidly evolving educational landscape, integrating STEAM (science, technology, engineering, arts, and mathematics) education into non-formal environments presents a dynamic approach to learning that emphasizes interdisciplinarity and flexibility.

1.1. STEAM Education in Non-Formal Environments: Crossing Interdisciplinarity with Flexibility

This section explores how non-traditional educational settings can foster STEAM learning by breaking down traditional subject barriers and allowing for more fluid, innovative educational approaches. Starting with STEM (science, technology, engineering, and mathematics) education, it will delve into how these environments not only enhance engagement and creativity but also address diverse learning needs, ultimately contributing to a more inclusive and comprehensive educational experience.

STEM education is an educational approach that fosters creativity, inquiry, dialogue, collaboration, and critical thinking by integrating the domains of science, technology, en-

gineering, and mathematics [14–16]. The STEAM approach has recently emerged as an extension of STEM, incorporating the Arts (A) to promote further creativity, risk-taking, collaborative engagement, experiential learning, and persistence in problem-solving [14]. The beginning of STEAM education was derived from STEM. The STEM movement emerged in the early 1990s, initially labelled as "SMET" by the National Science Foundation, which was later revised to STEM for phonetic reasons [17].

STEAM fosters active learning by integrating various disciplines, including the arts, delivering a comprehensive and motivational educational experience. It aims to shape present-day students into future leaders, innovators, scientists, engineers, educators, entrepreneurs, and lifelong learners equipped for the challenges of the 21st century [15,16]. Herro and Quigley [18] argue that STEAM education encompasses project-based learning, technology that fosters creativity and design, and a multifaceted, collaborative, interdisciplinary approach to problem-solving. In this way, it is understandable that STEAM relies on interdisciplinary educational approaches.

Interdisciplinarity originated from advancements in the 20th century and gained momentum as scientific research was organised and categorised in the 19th century. Technological advancements, population growth, increased industrialization, globalization, and modern governmental structures contributed to a growing demand for knowledge. As disciplines became more specialised, crossing boundaries between them became imperative [19,20]. Interdisciplinary approaches, such as STEAM, are increasingly advocated in formal education. However, due to the rigidity of the curriculum and time constraints, they are not always effectively achievable. Formal education is usually a compulsory component of citizens' lives, ensuring the development of fundamental skills and knowledge for adulthood [21,22]. However, the subjects covered in formal education are often limited and compartmentalised, sometimes failing to align with society's evolving needs [23], hindering interdisciplinarity operationalization.

Learning is a process that occurs across different lifelong contexts, crossing formal, non-formal, and informal educational settings. Thus, it becomes essential to discern among these various educational approaches, which complement each other in addressing citizens' diverse training needs. Formal education is the most widely recognised and heavily invested educational approach, based on predefined curricula or official programs, learning objectives, and structured teaching [21,23]. Non-formal education complements formal education and addresses educational needs beyond or supplementary to the curriculum [24]. Unlike formal education, non-formal education is characterised by intentional flexibility in content, methodologies, and approaches, adaptable to diverse knowledge areas and target audiences [22,23]. These features render non-formal education accessible to individuals of all ages and socio-cultural backgrounds [21] and allow greater flexibility and freedom in including interdisciplinary approaches such as STEAM.

1.2. STEAM Approach in Lifelong Education: Fostering 21st Century Competencies in Adult Education

In the context of lifelong education (LLE), the STEAM approach offers a transformative framework for adult education to develop essential 21st century competencies. This section is dedicated to how integrating STEAM into adult education (AE) programs can enhance critical thinking, problem-solving, creativity, and digital literacy among learners. It will explore how this interdisciplinary approach not only addresses the evolving needs of the modern workforce but also empowers adults to engage with complex global challenges. It is intended to illustrate the potential of STEAM education to create more skilled lifelong learners.

After the Second World War, which caused extensive devastation and widespread suffering, numerous global leaders aimed to foster peace and mutual understanding by eliminating "ignorance" and "illiteracy" across the globe [25], leading to the notion of "adult education" (AE). AE generally refers to the practice of teaching adults. It encompasses a wide range of educational activities designed to enhance adults' competencies.

These activities can occur in various settings, such as community colleges, universities, workplaces, and community centres. AE often focuses on providing vocational training and primary education (such as literacy and numeracy), continuing professional education, and personal enrichment courses [25,26]. It aims to meet the immediate educational needs of adults, helping them improve job prospects, achieve personal goals, or transition into new career paths [26].

On the other hand, LLE is a broader concept encompassing learning throughout an individual's life. It is a continuous process that includes formal, non-formal, and informal learning opportunities at all stages of life, from early childhood to old age [25,27]. LLE promotes the idea that learning is a continuous, lifelong process. It encourages individuals to engage in learning activities at any stage of life to adapt to changes in society, technology, and the labour market. This concept emphasizes the development of a learning society where citizens are empowered to learn and grow continuously, being inclusive of all age groups. LLE recognizes that learning can happen at any stage of life [27].

AE is a component of LLE, focusing specifically on adult learners. LLE, in contrast, encompasses the entire human lifespan, including individuals of all ages, from children to older people [25]. While both aim to enhance learning and personal growth, adult education is more targeted and immediate, addressing the specific needs of adults. LLE, however, promotes a continuous and holistic learning journey throughout an individual's life [25,27,28].

Promoting LLE through non-formal education encourages openness to interdisciplinary approaches. Educational institutions and training facilities must prioritise teaching and learning competencies and stimulate an appreciation for lifelong education and training [29]. Educational institutions, professional organizations, and employers should develop continuing education and training initiatives, promoting inclusiveness and reducing ageism.

The collaboration between non-formal activities and interdisciplinarity yields complete learning experiences and innovative problem-solving approaches. Non-formal educational activities, such as experiential learning and community engagement, provide diverse perspectives and practical insights. When combined with interdisciplinarity, which merges knowledge from multiple disciplines, these activities enhance creativity, critical thinking, and collaboration. This synergy between non-formal education and interdisciplinarity can enable adaptable competency sets, promote LLE, and catalyse transformative solutions to real-world problems.

STEAM education is a holistic approach to boosting critical thinking, creativity, and problem-solving skills. While traditionally associated with formal education, STEAM is increasingly admitted as vital in AE and LLE. This emphasis on continuous education reflects the evolving demands of the modern workforce and the need for individuals to adapt to the rapid technological advancements and complex global challenges of the 21st century. As industries evolve with technological advancements, adults must continuously update their competencies. STEAM education equips them to think critically and innovatively, which is essential for adapting to new roles and technologies [30].

From another perspective, STEAM subjects are inherently problem-based, teaching learners how to approach and solve real-world problems systematically. These skills are valuable in all sectors, from engineering and healthcare to business and the arts [31]. STEAM fosters a more holistic understanding of complex issues by integrating the arts (A) with traditional STEM subjects. This interdisciplinary approach can lead to more innovative solutions and a better appreciation of the societal impacts of technological and scientific advancements [32].

LLE programs need to be flexible to accommodate adults' schedules. Online courses (such as MOOCs), evening classes, and modular learning options are essential to make STEAM education accessible to working adults [33]. Collaborations between educational institutions and industries can provide adults with practical, hands-on experiences. These partnerships ensure that the competencies taught are directly relevant to current job markets and future trends [34,35]. Senior universities, local community centres, libraries, and

non-profits can offer STEAM workshops and courses. These programs can be tailored to community needs, promoting social inclusion and providing educational opportunities to underrepresented groups. Additionally, adults and seniors bring experience and knowledge to their education [36]. Recognising and integrating this prior learning can make STEAM education more relevant and engaging for adult learners. Some organizations already offer STEAM-based professional development workshops, focusing on upskilling employees in digital literacy, data analysis, and creative problem-solving [37].

Integrating STEAM education into LLE is essential for fostering a workforce capable of navigating and leading in a rapidly changing world. By providing flexible, accessible, and relevant learning opportunities, we can ensure that all citizens have the knowledge and skills needed to thrive in the 21st century. As ageing populations increase globally, collaborative approaches are essential to developing strategies and addressing associated economic, social, and health impacts [38]. Non-formal educational entities are crucial to advance learning opportunities across the lifespan. On the way to achieving this, museums and science centres offer educational tools and activities to address critical issues in science, technology, society, and the arts tailored to senior audiences. These institutions can catalyse tangible societal transformations by adopting creative methodologies grounded in interdisciplinary approaches [39].

Within this perspective, the present research aims to contribute to the discussion and inclusion of elder citizens through LLE via an interdisciplinary STEAM educational approach. The technological literacy among elderly individuals represents an additional dimension of social exclusion. In addressing this concern, adopting an interdisciplinary approach aimed at enhancing scientific and technological literacy is a principal motivation for implementing such educational sessions. Consequently, employing the STEAM framework offers a viable tool to impart scientific, artistic, mathematical, and technological competencies to senior audiences.

2. Methodology

Considering the theoretical framework presented earlier, the present research consisted of developing a sequence of non-formal education sessions on the golden ratio by employing a STEAM approach targeted towards a senior audience.

Methodologically, this research followed a quantitative method approach. Initially, as a diagnostic study, a survey was conducted through a questionnaire to assess the study participants' level of familiarity and knowledge regarding the golden ratio (RQ1). Based on the analysis of the collected data, an intervention program consisting of four sessions was developed to promote a STEAM approach to teach the golden ratio among the participating seniors. Afterwards, a quasi-experimental study was conducted to evaluate the intervention program's effectiveness in learning about this topic among seniors (RQ2). For this purpose, a pre- and post-test design was employed, with tests administered before and after the developed sessions.

The following sections describe the sample and data collection instruments and the procedure and data analysis and treatment techniques.

2.1. Sample

The convenience sample in this study consisted of 37 members (n = 37) from a senior university in the northern region of Portugal (with about 120 registered members, N ≈ 120) who were attending a non-formal science education course, representing 30.8% of the associated seniors. The characterization of the sample is detailed in Table 1.

Most participants were female (n = 31; 83.8%), with an average age of 71.3 years. Regarding their academic qualifications, the vast majority held a bachelor's or a 1st degree (n = 24; 64.9%) and were mainly retired primary school teachers.

It should be noted that as a convenience sample and not a probabilistic sample—one of the constraints in social and human sciences research—this study does not aim to establish generalizations but rather to contribute indicators about the research conducted.

Table 1. Sample characterisation (n = 37).

Demographic Data		Seniors (n = 37)	
		n	%
Gender	Female	31	83.8
	Male	6	16.2
Education	Elementary education	5	13.5
	Secondary education	5	13.5
	Bachelor/1st degree	24	64.9
	Master's degree/Post-graduation	3	8.1
Age	Mean	71.3	
	Standard deviation	5.68	
	Minimum	60	
	Maximum	84	

2.2. Data Collection Instruments

Considering the methodology and research questions defined previously, two data collection instruments—a diagnostic questionnaire and a pre- and post-test—were constructed and implemented. These are described in the following subsections. Three specialists in science education validated the data collection instruments through a literature review and analysis.

2.2.1. Questionnaire

The developed questionnaire consisted of three questions of various types—two closed-ended and one open-ended question—as described in Appendix A. The first question (Q1) consisted of six statements about the golden ratio with two response options—yes or no. Following the first question, the second (open-ended—Q2) aimed to explore the responses to the previous question in more depth. Finally, the third and last question (Q3) comprised 15 items in a five-point Likert scale regarding the golden ratio and its relationship with different STEAM (science, technology, engineering, arts, and mathematics) areas.

2.2.2. Pre- and Post-Tests

A four-question test was also developed, as described in Appendix B. The first question (T1) comprised four sub-questions (T1.1, T1.2, T1.3, and T1.4) related to the Fibonacci sequence and the golden ratio calculation. The second question (T2) was also composed of five sub-questions (T2.1, T2.2, T2.3, T2.4, and T2.5) related to the golden ratio applied to geometry, specifically to the regular pentagon and the pentagram. The third question (T3) aimed for participants to identify the presence of the golden ratio in natural and humanised elements. In the last question (T4), the participants were required to relate different images to the golden ratio and various areas of science, such as astronomy (T4.1), botany (T4.2), palaeontology (T4.3), and zoology (T4.4), as well as in the arts (T4.5). The test was scored out of 100 percentage points for subsequent classification.

2.3. Procedure

The intervention program of this research consisted of conducting four sessions (totalling six hours) with seniors attending a non-formal science education course. The selected educational methodology focused on inquiry-based learning integrated with the STEAM approach. The scientific theme for the four sessions was the golden ratio and the letter phi, regarding their presence in nature, which were applied to various STEAM areas, serving as a common and unifying denominator. Each session lasted approximately one and a half hours, with the first three held indoors and a final outdoor session, including a visit to a science centre and botanical garden to apply the learning developed in the classroom. In summary, each of the sessions was structured as follows:

- 1st Session—Mathematics: Introduction and calculation of the golden ratio and its presence in nature;

- 2nd Session—Science and technology: Exploration of the connections between the golden ratio and various scientific fields (for example, botany, zoology, mineralogy, and palaeontology, among others) by using QRCodes to watch videos and conduct internet research on the golden ratio phenomenon;
- 3rd Session—Engineering and the arts: Building the golden ruler, measuring the golden ratio, and exploring design and artistic applications of the golden ratio, including an art activity based on phi and golden spiral drawing;
- 4th Session—Application: Science centre and botanical garden visit to observe, measure, and identify different representations of the golden ratio.

From the data collection process perspective, there were three main elements. Initially, a questionnaire was administered to assess whether the participants had previously heard about the golden ratio—a diagnostic study. This element was particularly important for the planning and construction of the sessions that were developed. Subsequently, a quasi-experimental study was conducted, in which a pre- and post-test was administered to evaluate the sessions' impact on seniors' learning development. The answers to these data collection instruments were voluntary, ensuring the anonymity and confidentiality of the collected data, with informed consent obtained from the participants. Seniors took about 20 min to complete each of the data collection instruments. All the ethical standards inherent to the practice of educational research were followed throughout the research.

The collected data were analysed and treated according to their quantitative or qualitative nature. Quantitative data were analysed using IBM SPSS© version 29 software through descriptive statistical analysis and the performance of statistical tests, such as the paired sample *t*-test. These resulted from the classification of tests and closed-ended questions from the questionnaire. In turn, qualitative data, resulting from responses to the open-ended question of the questionnaire, underwent content analysis.

3. Results

This section is dedicated to analysing and discussing the results obtained in the diagnostic questionnaire and the pre- and post-tests. First, the analysis was conducted through each research question (RQ) and respective data collection instrument, namely, the diagnostic questionnaire (RQ1) and pre- and post-tests (RQ2; quasi-experimental study). Subsequently, an integrated discussion of the results obtained through these data collection instruments was conducted.

Sociodemographic questions, such as age, gender, academic qualifications, and professional activity, were asked of the study participants. However, when the chi-square test and Fisher's exact test were performed between these variables and the answers given to the various questions of the two data collection instruments, no statistically significant differences were obtained for a *p*-value of 0.05.

3.1. Diagnostic Study Results: Questionnaire

Table 2 describes the frequencies of answers to the first question (Q1) regarding seniors' knowledge about the golden ratio, Fibonacci sequence, and similar designations.

Table 2. Frequency of answers to Q1 of the diagnostic questionnaire (n = 37).

Question 1	Answers Frequency (n = 37)					
	Yes		No		Do Not Know	
	n	%	n	%	n	%
Q1.1. I have heard about the golden ratio.	3	8.1	33	89.2	1	2.7
Q1.2. I have heard about the golden number.	3	8.1	33	89.2	1	2.7
Q1.3. I have heard about the divine number or God's number.	3	8.1	33	89.2	1	2.7
Q1.4. I have heard about the golden spiral.	3	8.1	33	89.2	1	2.7
Q1.5. I have heard about the Fibonacci sequence.	2	5.4	34	91.9	1	2.7
Q1.6. I have heard about the Greek letter Phi (φ).	9	24.3	26	70.3	2	5.4

As explained in the previous table, seniors have a widespread lack of knowledge regarding the golden ratio and related concepts (n = 33; 89.2%). This lack of knowledge is even greater regarding the Fibonacci sequence (Q1.5, n = 34; 91.9%). On the other hand, there is slightly less ignorance regarding the Greek letter φ (phi), with almost a quarter of the participants showing knowledge of it (Q1.6, n = 9; 24.3%).

The lack of knowledge, as evidenced in the previous question (Q1), regarding the golden ratio and Fibonacci sequence is corroborated by the low number of responses to the open-ended question (Q2, n = 8; 21.6%). This question aimed to investigate the contexts in which participants had encountered or recognised the mentioned terms before participating in the study. Among those who responded to Q2, participants who demonstrated some understanding of the topic attributed their knowledge to their academic background (n = 3; 8.1%), specifically in mathematics or Greek or as a result of visits to museums or science centres (n = 2; 5.4%).

Table 3 presents the results of the questionnaire's third question (Q3), comprising 15 items on a five-point Likert scale. The answer frequencies and their respective mean and standard deviation (SD) were calculated.

Table 3. Frequency of answers to Q3 of the diagnostic questionnaire (n = 37).

Question 3	Answers Frequency (n = 37)												Mean	SD
	1		2		3		4		5		No Answer			
	n	%	n	%	n	%	n	%	n	%	n	%		
Q3.1	0	0.0	0	0.0	24	64.9	5	13.5	5	13.5	3	8.1	3.2	1.19
Q3.2	0	0.0	2	5.4	23	62.2	4	10.8	5	13.5	3	8.1	3.1	1.21
Q3.3	1	2.7	0	0.0	14	37.8	13	35.1	6	16.2	3	8.1	3.4	1.32
Q3.4	0	0.0	0	0.0	6	16.2	16	43.3	12	32.4	3	8.1	3.8	1.34
Q3.5	0	0.0	0	0.0	11	29.7	12	32.4	11	29.7	3	8.1	3.5	1.69
Q3.6	0	0.0	0	0.0	6	16.2	17	45.9	11	29.7	3	8.1	3.8	1.33
Q3.7	0	0.0	0	0.0	11	29.7	12	32.4	11	29.7	3	8.1	3.7	1.36
Q3.8	0	0.0	0	0.0	8	21.6	13	35.1	10	27.0	6	16.2	3.4	1.67
Q3.9	0	0.0	0	0.0	5	13.5	19	51.4	8	21.6	5	13.5	3.5	1.54
Q3.10	0	0.0	0	0.0	5	13.5	17	45.9	10	27.0	5	13.5	3.6	1.57
Q3.11	0	0.0	0	0.0	8	21.6	14	37.8	11	29.7	4	10.8	3.7	1.48
Q3.12	0	0.0	0	0.0	10	27.0	11	29.7	11	29.7	5	13.5	3.5	1.59
Q3.13	0	0.0	0	0.0	5	13.5	17	45.9	12	32.4	3	8.1	3.9	1.34
Q3.14	0	0.0	0	0.0	5	13.5	19	51.4	10	27.0	3	8.1	3.8	1.31
Q3.15	0	0.0	0	0.0	5	13.5	19	51.4	10	27.0	3	8.1	3.8	1.31

1—Completely disagree; 2—Partially disagree; 3—Neither agree nor disagree; 4—Partially agree; 5—Completely agree.

Based on the data presented in the previous table, the participants partially agreed (fourth level on the Likert scale) regarding most statements (from Q3.4 to Q3.15), recognising the presence of the golden ratio in various areas of knowledge. One indicator that seems relevant to emphasise is the fact that there is the same frequency of responses at levels four and five (n = 11; 29.7%, respectively) in Q3.12, indicating that participants recognise the golden ratio's relevance to a holistic understanding of science.

Regarding the mean obtained for each statement, it is noticeable that the participants show greater agreement regarding the possibility of the golden ratio contributing to the application of sustainable measures (Q3.13, mean = 3.9; SD = 1.34). Conversely, seniors demonstrated a lower level of agreement with statements Q3.2 and Q3.1, not relating the golden ratio to the Fibonacci sequence and divine proportion (Q3.2, mean = 3.1; SD = 1.21) nor its usage since antiquity (Q3.13, mean = 3.2; SD = 1.19), respectively. These results align with the frequencies obtained in these statements, as most seniors indicated level three (neither agree nor disagree) as the most frequent response (Q3.2, n = 23; 62.2% and Q3.1, n = 24; 64.9%, respectively).

It is worth noting that despite a generalised partial agreement regarding the statements, the overall results of the questionnaire reveal a certain degree of senior participants' unfamiliarity with the golden ratio. This indicator was particularly important in the design of the STEAM intervention program that was developed and implemented with this audience, highlighting the novelty factor regarding the theme addressed.

3.2. Quasi-Experimental Study Results: Pre- and Post-Tests

Table 4 shows the results of the descriptive statistics of the scores obtained in the pre- and post-tests by the seniors.

Table 4. Descriptive statistics of the scores obtained by seniors in the pre- and post-test.

Descriptive Statistics	Pre-Test (%)	Post-Test (%)
Mean	51.4	83.8
Standard deviation (SD)	16.21	16.31
Minimum	5	50
Maximum	80	100

According to the previous table, the means of the scores were higher in the post-test compared to the means recorded in the pre-test. The mean of the scores obtained by the seniors in the pre-test was satisfactory (mean = 51.4%; SD = 16.21). On the other hand, the mean achieved in the post-test was good (mean = 83.8%; SD = 16.31), showing an increase of 32.4%. A paired sample *t*-test was also conducted regarding the difference between the means of the pre- and post-test scores, and statistical significance was obtained between them ($t_{(36)} = -11.031$; $p < 0.001$). The frequencies of correct answers were calculated to detail the analysis of the results of the answers to the test questions, as explained in the following tables (Tables 5–7).

Table 5. Frequency of correct answers to the questions T1 and T2 of the pre- and post-tests (n = 37).

Questions	Pre-Test				Post-Test			
	Correct		Incorrect		Correct		Incorrect	
	n	%	n	%	n	%	n	%
T1.1	33	89.2	4	10.8	34	91.9	3	8.1
T1.2	7	18.9	30	81.1	22	59.5	15	40.5
T1.3	9	24.3	28	75.7	28	75.7	9	24.3
T1.4	19	51.4	18	48.6	23	62.2	14	37.8
T2.1	30	81.1	7	18.9	34	91.9	3	8.1
T2.2	17	45.9	20	54.1	30	81.1	7	18.9
T2.3	13	35.1	24	64.9	33	89.2	4	10.8
T2.4	27	73.0	10	27.0	33	89.2	4	10.8
T2.5	11	29.7	26	70.3	34	91.9	3	8.1

Table 6. Frequency of correct answers to the question T3 of the pre- and post-tests (n = 37).

Options	Pre-Test		Post-Test	
	n	%	n	%
Incorrect	0	0.0	0	0.0
1 correct	2	5.4	1	2.7
2 correct	2	5.4	1	2.7
3 correct	6	16.2	3	8.1
4 correct	14	37.8	6	16.2
5 correct	13	35.1	8	21.6
6 correct	0	0.0	18	48.6

Table 7. Frequency of correct answers to the question T4 of the pre- and post-tests (n = 37).

Options	Pre-Test		Post-Test	
	n	%	n	%
Incorrect	8	21.6	0	0.0
1 correct	5	13.5	3	8.1
2 correct	11	29.7	3	8.1
3 correct	11	29.7	3	8.1
4 correct	1	2.7	9	24.3
5 correct	1	2.7	19	51.4

Table 5 describes the frequencies of correct responses in the pre- and post-tests for the first two questions (T1 and T2).

Through the analysis of the previous table, it is possible to verify that there was an improvement in the performance of seniors in the post-test on all questions. Regarding the pre-test, the participants showed good performance in questions T1.1 (n = 33; 89.2%), T2.1 (n = 30; 81.1%), and T2.4 (n = 27; 73.0%) since a large portion of participants were able to correctly complete the sequence, as well as identify the golden ratio present in the figure and the regular pentagons inscribed in it, respectively. In the remaining questions, the performance was insufficient except for question T1.4 (n = 19; 51.4%). On the other hand, in the post-test, seniors performed excellently in questions T1.1 (n = 34; 91.9%), T2.1 (n = 34; 91.9%), and T2.5 (n = 34; 91.9%). In the remaining questions, the participants demonstrated having developed knowledge, reaffirming the positive impact of the intervention program on learning. Despite the positive results, the questions in which seniors showed the most significant difficulty in the post-test were T1.2 (n = 22; 59.5%) and T1.4 (n = 23; 62.2%), reflecting the difficulty in calculating fractions and identifying geometric polygons related to the Fibonacci sequence.

Table 6 describes the frequencies of correct answers to question T3 in both the pre-test and post-test. Similar to previous questions, the seniors showed improved results, with more correct answers in the post-test.

In the pre-test, most participants were able to correctly answer four (n = 14; 37.8%) or five (n = 13; 35.1%) options correctly, with none of the seniors (n = 0; 0.0%) being able to answer all properly. In turn, in the post-test, most participants were able to answer all options correctly (n = 18; 48.6%) or at least five of them (n = 8; 21.6%).

Finally, and once again, as observed in previous questions, in the last question, T4, a performance improvement is noticeable in the post-test, as reflected in Table 7.

In the last question (T4) in the pre-test, many seniors were able to identify only two (n = 11; 29.7%) or three (n = 11; 29.7%) items correctly. Compared with the performances in the post-test, more than half of the participants (n = 19; 51.4%) correctly identified all five areas of knowledge present in the images. Additionally, it is noteworthy that no participant (n = 0; 0.0%) missed any item in the post-test.

The evolution recorded, both in average scores and in the frequencies of correct responses in all test questions, reaffirms the effectiveness of the non-formal STEAM intervention program in fostering multiple learnings about the golden ratio and Fibonacci sequence among participants, indicating that this approach enhanced their scientific literacy.

4. Discussion

The scarcity of educational science programs tailored for seniors is a significant issue. This is evident in the lack of scientific publications on LLE that utilise the STEAM approach and explore mathematical concepts such as the golden ratio. This educational gap is a pressing challenge given that seniors are a growing population that can greatly benefit from educational programs that foster active ageing and well-being.

While there is a lack of specific studies on applying STEAM and the golden ratio in senior education, the existing literature on using the STEAM approach in adult education points to promising outcomes. For instance, Hsiao and Su [40] found that integrating

STEAM education with virtual reality (VR) can significantly enhance learning outcomes and student motivation. These interdisciplinary approaches are crucial for LLE, providing adult learners with engaging and motivating educational experiences. However, more research is needed to explore the potential benefits of these approaches in senior education.

The positive results obtained in the present study are consistent with the specialised literature on the potential of the STEAM approach when applied to different segments of society. For example, Astawan et al. [41] examined how integrated STEM education can improve critical and creative thinking skills. Although the primary focus is on younger students, these findings could be applied to LLE, indicating that seniors could also benefit from STEAM approaches to enhance their scientific literacy and understanding of concepts such as the golden ratio [42].

Finally, other researchers have explored the educational potential of the golden ratio for developing scientific literacy, connecting mathematical concepts to real-world applications across various fields. This approach can be particularly engaging for senior citizens, offering a holistic and interdisciplinary educational experience [43].

Some future lines of research are suggested, amongst others, such as (i) conducting comparative studies between STEAM and other interdisciplinary educational approaches to evaluate their respective impacts on senior learners' engagement, knowledge, and application of competencies in real-life contexts; (ii) studying the effectiveness of customised STEAM education programs tailored to the diverse needs of senior learners to examine personalised learning paths, consider individual interests and prior knowledge, and influence motivation and educational outcomes; (iii) assessing the effectiveness of various non-formal education settings (e.g., community centres, online platforms, and museums) in providing STEAM education to senior populations, identifying best practices and barriers to implementation in different environments; and (iv) creating and validating assessment tools specifically designed to measure the educational outcomes and cognitive advantages of senior learners participating in STEAM programs.

5. Conclusions

The availability of specific science educational programs for the senior population is notably limited, as is the publication of studies on LLE and AE that employ the STEAM approach and explore concepts (such as the golden ratio). This gap represents an area that requires greater attention and development, especially considering the growing senior population, which can significantly benefit from such educational initiatives. Applying STEAM education shows promise in enhancing scientific literacy and motivation among adult learners. The STEAM approach provides a holistic view of science that is particularly relevant and engaging for seniors.

This research showed that by applying mathematical concepts, such as the golden ratio, in interdisciplinary contexts, STEAM education can make learning more compelling and accessible, tangibly bridging theory and practice. Educational programs utilising the STEAM approach can promote active and healthy ageing, stimulating the minds of seniors and encouraging LLE. By connecting the golden ratio to practical applications in areas such as the arts and natural sciences, these programs can offer a rich and motivating educational experience. The integration of these areas can help seniors develop a better understanding of scientific concepts and appreciate the beauty and functionality of mathematics in everyday life.

STEAM education can enrich seniors' educational experience, promote scientific literacy, and offer a comprehensive educational approach by combining various fields of knowledge. This promising area deserves further research and development to maximise educational benefits for the senior population.

Author Contributions: Conceptualization, N.T., T.R. and C.V.; methodology, T.R. and C.V.; validation, T.R. and C.V.; formal analysis, N.T. and T.R.; investigation, N.T. and T.R.; resources, N.T.; writing—original draft preparation, N.T. and T.R.; writing—review and editing, T.R. and C.V.; supervision, C.V. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by Strategic Funding (refs. UIDB/04423/2020 and UIDP/04423/2020) through national funds provided by the Portuguese National Funding Agency for Science, Research, and Technology (Fundação para a Ciência e a Tecnologia [FCT]).

Institutional Review Board Statement: This research was conducted externally to FCUP, MHNC-UP, and CIIMAR, for which an Institutional Review Board Statement was not required. A cooperation protocol was signed with the direction of the cooperating senior university, and this research was carried out within the scope of the "Science" discipline led by T.R. and C.V. Additionally, informed consent was obtained from the participants regarding data collection.

Informed Consent Statement: The study was conducted in accordance with the Declaration of Helsinki for studies involving humans, following the co-operation protocol signed between the research team and the Board of Directors of the cooperating institution on the date of 16 January 2024. Additionally, informed consent was obtained from all participants involved in the study.

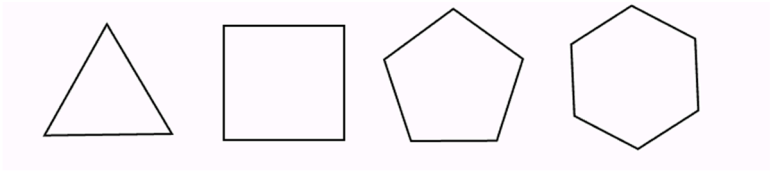
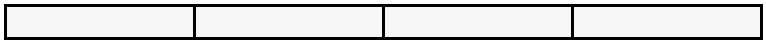
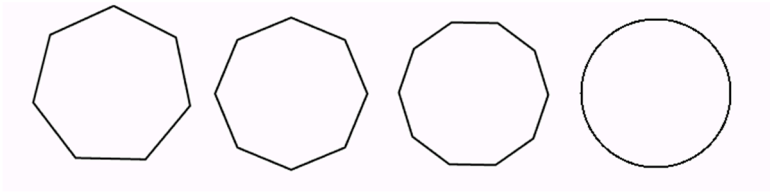
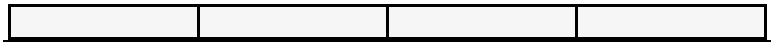
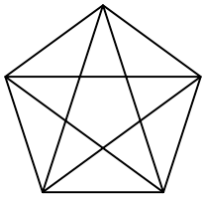
Data Availability Statement: The data presented in this study are available on request from the corresponding author due to privacy and ethical reasons.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A. Questionnaire

Questions
Q1. In this section, you are asked to refer to your perception regarding the designations of each statement. Mark with a cross (X) in Yes or No about your knowledge of each statement. **Q1.1.** I have heard about the golden ratio. **Yes** ___; **No**: ___. **Q1.2.** I have heard about the golden number. **Yes** ___; **No**: ___. **Q1.3.** I have heard about the divine number or God's number. **Yes** ___; **No**: ___. **Q1.4.** I have heard about the golden spiral. **Yes** ___; **No**: ___. **Q1.5.** I have heard about the Fibonacci sequence. **Yes** ___; **No**: ___. **Q1.6.** I have heard about the Greek letter Phi (pronounced "fee"). **Yes** ___; **No**: ___.
Q2. If you answered true to at least one of the statements from Q1.1 to Q1.6, give an example of where you recognised one of the terms you marked as Yes. _____
Q3. Indicate for each statement your level of agreement (with 1—completely disagree and 5—completely agree) on each of the subjects. **Q3.1.** The golden ratio has been used since antiquity. ___ **Q3.2.** The golden ratio is related to the golden number and the divine proportion. ___ **Q3.3.** The golden ratio can be applied in science. ___ **Q3.4.** The golden ratio can be applied in technology. ___ **Q3.5.** The golden ratio can be applied in engineering. ___ **Q3.6.** The golden ratio can be applied in the arts. ___ **Q3.7.** The golden ratio can be applied in mathematics. ___ **Q3.8.** The golden ratio is present in the harmony of natural and human constructions. ___ **Q3.9.** The golden ratio allows for a greater degree of understanding of the world. ___ **Q3.10.** The golden ratio allows for establishing relationships between different areas of knowledge. ___ **Q3.11.** The golden ratio increases the degree of comprehension of various areas of knowledge. ___ **Q3.12.** The golden ratio allows for an understanding of the holistic view of science. ___ **Q3.13.** The golden ratio enhances the application of sustainability measures. ___ **Q3.14.** The golden ratio allows for the establishment of space and energy optimization measures. ___ **Q3.15.** The development of resources based on the golden ratio provides measures for improvement and efficiency. ___

Appendix B. Pre- and Post-Test

Questions
T.1. The Fibonacci sequence is a succession of natural numbers in which each term, starting from the third, is given by the sum of its two predecessor terms. This sequence has a connection with the golden ratio and the golden number since the sequence of ratios between two consecutive terms of the Fibonacci sequence tends to this value. **T.1.1.** Complete the following numerical sequence: 1, 1, 2, 3, 5, 8, ____, ____, ____, ____, ____ **T.1.2.** Divide the sequence values by the previous number to obtain a decimal numeric value: 1/1 = 1.0 2/1 = 2.0 3/2 = 1.5 5/3 = 1.666 __/__=__ __/__=__ __/__=__ __/__=__ __/__=__ **T.1.3.** Indicate what approximate value the final fraction presents: _____ **T.1.4.** Place a cross (X) on the geometric polygons that you consider to be related to the Fibonacci sequence   Future lines of research were proposed to enrich the discussion.  
T.2. Note the pentagram inserted into the regular pentagon  **T.2.1.** Do you consider the figure to be an example of the golden ratio? _____ **T.2.2.** How many identical triangles can you identify in the figure? _____ **T.2.3.** How many groups of identical triangles can you identify in the figure? _____ **T.2.4.** How many identical regular pentagons can you identify in the figure? _____ **T.2.5.** Give an example of the existence of this figure in the natural world. _____

Questions

T.3. The existence of the golden ratio in various natural and humanised elements. From the figures presented, list which ones can be considered examples of the existence of the golden ratio. Place a cross (X) on the images that you consider to be examples of the golden ratio.

Images	Has a golden ratio	Does not have a golden ratio
Passionflower (*Passiflora edulis*)		
Shell of *Nautilus sp.*		
Urban construction		
Example of granite rock		
Sunflower (*Helianthus helios*)		
National Geographic logo		

T.4. Holistic view of science: State the area of knowledge to which each figure relates.

T.4.1. (Milky Way image) _____

T.4.2. (*Aloe polyphylla* image) _____

T.4.3. (Ammonite fossil image) _____

T.4.4. (Shell of *Nautilus* sp. image) _____

T.4.5. (Twitter logo image) _____

References

1. Bjursell, C. Inclusion in education later in life: Why older adults engage in education activities. *Eur. J. Res. Educ. Learn. Adults* **2019**, *10*, 215–230. [CrossRef]
2. Cardoso, A.; Ribeiro, T.; Vasconcelos, C. What Is Inside the Earth? *Sci. Educ.* **2018**, *27*, 715–736. [CrossRef]
3. Pais, R.; Ruano, L.; Moreira, C.; Carvalho, O.P.; Barros, H. Prevalence and incidence of cognitive impairment in an elder Portuguese population (65–85 years old). *BMC Geriatr.* **2020**, *20*, 470. [CrossRef]
4. Najar, J.; Östling, S.; Gudmundsson, P.; Sundh, V.; Johansson, L.; Kern, S.; Guo, X.; Hällström, T.; Skoog, I. Cognitive and physical activity and dementia: A 44-year longitudinal population study of women. *Neurology* **2019**, *92*, e1322–e1330. [CrossRef]
5. Formosa, M. Critical Geragogy: Situating Theory in Practice. *J. Contemp. Educ. Stud.* **2012**, *5*, 36–54.
6. Maulod, A.; Lu, S.Y. "I'm slowly ageing but I still have my value": Challenging ageism and empowering older persons through lifelong learning in Singapore. *Educ. Gerontol.* **2020**, *46*, 628–641. [CrossRef]
7. National Academies of Sciences, Engineering, and Medicine. *How People Learn II: Learners, Contexts, and Cultures*; The National Academies Press: Washington, DC, USA, 2018. [CrossRef]
8. Formosa, M. (Ed.) *The University of the Third Age and Active Ageing: European and Asian-Pacific Perspectives*; Springer: Cham, Switzerland, 2019. [CrossRef]
9. Formosa, M. Four decades of Universities of the Third Age: Past, present, future. *Ageing Soc.* **2014**, *34*, 42–66. [CrossRef]
10. Romaioli, D.; Contarello, A. Resisting ageism through lifelong learning. Mature students' counter-narratives to the construction of aging as decline. *J. Aging Stud.* 2021; 57, 100934. [CrossRef]
11. United Nations. *Transforming Our World: The 2030 Agenda for Sustainable Development (A/RES/70/1)*; United Nations: New York, NY, USA, 2015.
12. Officer, A.; Thiyagarajan, J.A.; Schneiders, M.L.; Nash, P.; de la Fuente-Núñez, V. Ageism, Healthy Life Expectancy and Population Ageing: How Are They Related? *Int. J. Environ. Res. Public Health* **2020**, *17*, 3159. [CrossRef]
13. Ayalon, L.; Tesch-Römer, C. *Contemporary Perspectives on Ageism*; Springer: Cham, Switzerland, 2018. [CrossRef]
14. Aguilera, D.; Ortiz-Revilla, J. STEM vs. STEAM Education and Student Creativity: A Systematic Literature Review. *Educ. Sci.* **2021**, *11*, 331. [CrossRef]
15. Belbase, S.; Mainali, B.R.; Kasemsukpipat, W.; Tairab, H.; Gochoo, M.; Jarrah, A. At the dawn of science, technology, engineering, arts, and mathematics (STEAM) education: Prospects, priorities, processes, and problems. *Int. J. Math. Educ. Sci. Technol.* **2022**, *53*, 2919–2955. [CrossRef]
16. Ribeiro, T.; Silva, J.; Paz, M.; Cardoso, A.; Teles, N.; Nogueira, C.; Ribeiro, T. Strengthening Bridges Between STEM Education and Entrepreneurship: Pathways to Societal Empowerment Towards Sustainability. In *Enhancing Entrepreneurial Mindsets Through STEM Education*; Kaya-Capocci, S., Peters-Burton, E., Eds.; Springer International Publishing: Berlin/Heidelberg, Germany, 2023; pp. 25–47. [CrossRef]

17. Martín-Páez, T.; Aguilera, D.; Perales-Palacios, F.J.; Vílchez-González, J.M. What are we talking about when we talk about STEM education? A review of literature. *Sci. Educ.* **2019**, *103*, 799–822. [CrossRef]
18. Herro, D.; Quigley, C. Innovating with STEAM in middle school classrooms: Remixing education. *Horiz.* **2016**, *24*, 190–204. [CrossRef]
19. Clark, S.G.; Wallace, R.L. Integration and interdisciplinarity: Concepts, frameworks, and education. *Policy Sci.* **2015**, *48*, 233–255. [CrossRef]
20. Raento, P. Interdisciplinarity. *Int. Encycl. Hum. Geogr.* **2020**, *357*, 363357–363363. [CrossRef]
21. La Belle, T.J. Formal, nonformal and informal education: A holistic perspective on lifelong learning. *Int. Rev. Educ.* **1982**, *28*, 159–175. [CrossRef]
22. Souto-Otero, M. Validation of non-formal and informal learning in formal education: Covert and overt. *Eur. J. Educ.* **2021**, *56*, 365–379. [CrossRef]
23. Johnson, M.; Majewska, D. *Formal, Non-Formal, and Informal Learning: What Are They, and How can We Research Them?* Research Report; Cambridge University Press & Assessment: Cambridge, UK, 2022.
24. Tudor, S.L. Formal–non-formal–informal in education. *Procedia-Soc. Behav. Sci.* **2013**, *76*, 821–826. [CrossRef]
25. Benavot, A.; Hoppers, C.O.; Lockhart, A.S.; Hinzen, H. Reimagining adult education and lifelong learning for all: Historical and critical perspectives. *Int. Rev. Educ.* **2022**, *68*, 165–194. [CrossRef]
26. Bertrand, M.G.; Namukasa, I.K. A pedagogical model for STEAM education. *J. Res. Innov. Teach. Learn.* **2023**, *16*, 169–191. [CrossRef]
27. Aspin, D.N.; Chapman, J.D. Lifelong Learning: Concepts and Conceptions. In *Philosophical Perspectives on Lifelong Learning*; Aspin, D.N., Ed.; Springer: Dordrecht, The Netherlands, 2007; pp. 19–38.
28. Desjardins, R. *Learning for Well Being. Studies Using the International Adult Literacy Survey*; Stockholm University: Stockholm, Sweden, 2004.
29. Burns, R. *The Adult Learner at Work: The Challenges of Lifelong Education in the New Millennium*, 2nd ed.; Routledge: London, UK, 2002.
30. Quigley, C.F.; Herro, D. "Finding the Joy in the Unknown": Implementation of STEAM Teaching Practices in Middle School Science and Math Classrooms. *J. Sci. Educ. Technol.* **2016**, *25*, 410–426. [CrossRef]
31. Watson, A.D.; Watson, G.H. Bonus Article: Transitioning STEM to STEAM: Reformation of Engineering Education. *J. Qual. Particip.* **2013**, *36*, 1–5.
32. Bequette, J.W.; Bequette, M.B. A Place for Art and Design Education in the STEM Conversation. *Art Educ.* **2012**, *65*, 40–47. [CrossRef]
33. Ribeiro, S. Digital storytelling: An integrated approach to language learning for the 21st century student. *Teach. Engl. Technol.* **2015**, *15*, 39–53.
34. Hacıoğlu, Y. The effect of STEM education on 21st century skills: Preservice science teachers' evaluations. *J. STEAM Educ.* **2021**, *4*, 140–167.
35. Krüger Mariano, W.; Chiappe, A. Habilidades del siglo XXI y entornos de aprendizaje STEAM: Una revisión. *Rev. Educ. Distancia (RED)* **2021**, *21*, 68. [CrossRef]
36. Werquin, P. *Recognition of Non-Formal and Informal Learning: Country Practices*; OCDE: Paris, France, 2010.
37. Okojie, M.C.P.O.; Olinzock, A.A.; Okojie-Boulder, T.C. The Pedagogy of Technology Integration. *J. Technol. Stud.* **2006**, *32*, 66–71. [CrossRef]
38. Garnett, A.; Sangrar, R.; Harvey, K.; Weldrick, R.; Hatzifilalithis, S.; Kalu, M.; Dunford, E.; Patocs, A.; Kajaks, T. Silos to Synergy: Experiences of an Interdisciplinary Trainee Network. *J. Scholarsh. Teach. Learn.* **2023**, *23*, 21–38.
39. Teles, N.; Chaves, R.; Torres, J.; Fonseca, M.J. Connections Between Nature and Mathematics: The Fibonacci's Sequence in the Natural History and Science Museum of the University of Porto. In *Handbook of Research on Interdisciplinarity Between Science and Mathematics in Education*; Cavadas, B., Branco, N., Eds.; IGI Global: Hershey, PA, USA, 2023; pp. 18–38.
40. Hsiao, P.-W.; Su, C.-H. A Study on the Impact of STEAM Education for Sustainable Development Courses and Its Effects on Student Motivation and Learning. *Sustainability* **2021**, *13*, 3772. [CrossRef]
41. Astawan, I.G.; Suarjana, I.; Werang, B.; Asaloei, S.; Sianturi, M.; Elele, E.; Elele, E.C. STEM-based scientific learning and its impact on students' critical and creative thinking skills: An empirical study. *J. Pendidik. IPA Indones.* **2023**, *12*, 482–492. [CrossRef]
42. Hacioglu, Y.; Gulhan, F. The Effects of STEM Education on the Students' Critical Thinking Skills and STEM Perceptions. *J. Educ. Sci. Environ. Health* **2021**, *7*, 139–155. [CrossRef]
43. Iosa, M.; Morone, G.; Paolucci, S. Phi in physiology, psychology and biomechanics: The golden ratio between myth and science. *Biosystems* **2018**, *165*, 31–39. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.