WP 2: MAP

Deliverable 2.1

Conceptual Framework

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1 Background

1.1 SySTEM 2020

SySTEM 2020 is a multi-faceted project focused on evaluating the delivery and impact of science[1] learning that occurs outside of the classroom. The intention of the project is to map current informal[2] learning structures across Europe, evaluate a number of existing transdisciplinary programmes, and use this information to design a robust framework for informal science education that may be utilised by educators and learners alike. Platforms for self-evaluation will be piloted to examine individual learning ecologies, document informal science learning, and provide scope for accreditation. The project will study practices in 19 European countries, and will cover learners between the ages of 9-20 years old. These learners will include those from geographically remote, socio-economically disadvantaged, minority and/or migrant communities.

There are five main objectives for SySTEM 2020:

1. To thoroughly assess existing informal and non-formal science learning in Europe.
2. To establish challenges surrounding informal science education, and identify necessary factors that support fair inclusion and engagement in this field by learners. This will involve stakeholders and learners through a co-design format.
3. To design consolidated frameworks and tools for facilitating informal science education, including a technology platform that can be used by STEM learners, allowing them to gain credentialisation.
4. To reflect on and evaluate the impact of the above outlined pilot studies, and adapt the learning tools accordingly to improve their efficacy.
5. To disseminate the learnings of SySTEM 2020 via research papers, conferences and workshops, as well as engage and inform stakeholders, peers, and the general media to foster public awareness of this field.

1.2 Purpose of This Paper

The purpose of this paper is to undertake a systematic literature review of the existing non-formal and informal learning frameworks in Europe, categorise these existing frameworks, identify the gaps in the field, and finally to propose a consolidated framework that will provide the basis for future work in this project. This deliverable is a first version of this paper, which will be updated throughout the lifecycle of the project and will eventually form a white paper to be used by the project.

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[1] 'Science' here is used for brevity. The scope of the project includes science, technology, engineering, and mathematics (STEM) and related areas, and STEAM, when the aforementioned includes the arts.

[2] As above, 'informal' here means 'outside of the classroom'. Definitions of informal, non-formal, and semi-formal education follow in the document.

This white paper will set the parameters by which informal education programmes and frameworks can be identified and evaluated across Europe. To date, there is no comprehensive systematic literature review on this topic. The relevance of informal education with respect to science learning is becoming increasingly apparent. This review aims to fill the gap in the research literature surrounding this field. Previous reviews have identified good practices for employing informal science education, including its importance in science learning, however they have failed to identify and tackle the challenges in the field, as well as standardising the plethora of programmes. In addition to this, an inconsistency in the definitions of both informal and non-formal education has been identified. This paper will aim to consolidate the viewpoints of our analysed literature and create a consensus definition for these terms to serve as a reference for future work on this project.

In addition to contributing to the field in general, this review also serves as a launchpad for future work pertinent to SySTEM 2020. This review will fulfil Task 2.1 of Work Package 2: *MAP: Science Learning at Organisational Level*. Task 2.1 is the development of a conceptual framework for researching science learning outside the classroom, and will be the objective of this review.

Principles outlining the inclusion and exclusion criteria for informal science education programmes in Europe will be constructed. Programmes that meet the appropriate criteria will be categorised according to numerous relevant factors pertaining to their individual frameworks. The data from these inputs will be analysed and a consolidated framework will be proposed in this review. This framework will acknowledge and address any gaps identified in existing frameworks such that a comprehensive, accessible, and engaging framework resides. Having said that, the first deliverable version of this paper will not provide a definitive list of criteria for exclusion or inclusion of programmes, as producing such a list has dependencies on information gathered throughout the project from programmes.

Subsequent tasks in Work Package 2 are centred around the mapping of informal science education programmes across Europe, for which the proposed framework contained herein will provide a reference for classifying these programmes prior to their input into the online map.

1.3 Objectives

The objectives of this paper are as follows:

1. Carry out a systematic literature review on existing informal science education frameworks in Europe.
2. Produce a white paper outlining the current frameworks of informal science education research, identifying existing gaps.
3. Construct a categorisation technique to employ on existing frameworks for informal science education programmes.
4. Identify current strengths and challenges faced by existing informal science education programmes.
5. Propose a comprehensive framework for informal science education programmes.

2. Definition of Terms

	Formal	**Informal**	**Other**
Coombs *et al.* (1973)	Formal Education: in the initial education and training system	Informal Education: true lifelong learning process, daily experience (friends, neighbours etc.)	Non-Formal Education: organised but outside the formal sector; serve identifiable clientele and has learning objectives
ISCED 97	Formal Education: in the initial education and training system, below age 20/25	Informal Learning is intentional, but it is less organised and less structured	Non-Formal Education: Organised and sustained; all ages; within and outside education institutions; education programmes for adults (literacy..)
EC (2000)	Formal Learning: in education and training institutions and leads to a qualification	Informal Learning: from everyday situation; *not necessarily intentional*	Non-Formal Learning: alongside mainstream system of education; does not lead to a qualification
EUROSTAT (2000/06)	[ISCED 97]	Informal Learning: intentional, less organised, less structured than formal learning	[ISCED 97]
CEDEFOP (2005)	Planned and intentional learning activities	Not planned and non-intentional learning activities	Planned and intentional activities, no learning objective
OECD (2007a)	Formal Learning: in an educational institution, adult training centre or in the workplace	Informal Learning: from daily work, family or leisure activities. Not organised or structured. Unintentional	Non-Formal Learning: programmed but not assessed and does not lead to a qualification; intentional
CEDEFOP (2008/14)	Learning that occurs in an organised and structured environment (e.g. in an education or training institution or on the job) Explicitly designated as learning (in terms of objectives, time or resources) Intentional from the learner's point of view. It typically leads to validation and certification.	Learning resulting from daily activities related to work, family or leisure. Not organised or structured in terms of objectives, time or learning support. In most cases unintentional from the learner's perspective.	Learning embedded in planned activities not explicitly designated as learning (in terms of learning objectives, learning time or learning support). Non-formal learning is intentional from the learner's point of view.
NCVER	Learning that takes place through a structured	Learning resulting from daily activities related to	Any organised and sustained educational

| (2013/17) | program of instruction which is generally recognised by the attainment of a formal qualification or award (for example, a certificate, diploma or degree). | work, family or leisure. It is not organised or structured (in terms of objectives, time or learning support). Informal learning in most cases is unintentional from the learner's perspective. It typically does not lead to certification. | activity that does not correspond exactly to the definition of formal education. Non-formal education may therefore take place both within and outside educational institutions, and cater to persons of all ages. |
| UNESCO (2015) | | Learning that results from daily activities | Structured learning that lies outside of the formal system |

3. Methods

3.1   Systematic Literature Review

A systematic literature review was carried out to establish the scale and scope of existing conceptual frameworks for classifying informal science learning. Traditionally, white paper reports include a state-of-the-field review to provide context. Sometimes these reviews can be basic narrative-style interpretations of the existing literature. The difference between a systematic literature review and these other type of basic reviews is that systematic literature reviews require a well-defined and rigorous approach when appraising the literature in a specific area (Fink, 2005; Budgen & Brereton, 2006). Basic reviews may provide some useful context, but are of little scientific value, whereas systematic literature reviews can provide a definitive assessment of a field of work and can then guide future research in that area. Gough, Oliver, and Thomas (2017) point out that "reviews of research are themselves pieces of research and so need to be undertaken according to some sort of method" (p. 4). If research is undertaken in an area without the existence of a systematic literature review, that research runs the risk of being unnecessary at best and unethical at worst. A systematic literature review is an ideal way to summarise the current best evidence of existing conceptual frameworks in informal science education.

Building on the established processes for systematic reviews (Khan, Kunz, Kleijnen, & Antes, 2003; Cronin, Ryan, & Coughlan, 2008; Denyer & Tranfield, 2009; Okoli & Schabram, 2010), this systematic literature review will:

- Identify relevant primary studies in the field
- Search through the available literature using clear, well-defined, and transparent search criteria
- Explicitly highlight and justify the inclusion and exclusion criteria to minimise bias and error
- Collate these studies with any other relevant research conducted in this area

- Systematically analyse all gathered content
- Summarise the available evidence based on the review

3.2   Research Questions

The research questions were developed to be practical, specific, and answerable, following the guidelines suggested by Jensen and Laurie (2016) along with best practices from the Campbell Collaboration, an international network which publishes systematic reviews of social and economic interventions since 2000 (Campbell Collaboration, 2015).

The research questions are:

1. How does the existing academic literature classify informal science learning activities?
2. What is the most useful conceptual framework for classifying science learning outside the classroom and connecting it to formal education?

3.3   Inclusion & Exclusion Criteria

The inclusion criteria consist of the rules of selection for determining which studies/publications are included in the systematic review. The starting point for choosing the selection criteria is the research questions themselves, which are unpacked to determine the boundaries of the search and how extensive it needs to be. For this review, the inclusion criteria extended to both theoretical and empirical peer-reviewed scholarly articles. Conference papers, commissioned reports from reputable organisations - known as "grey literature" (McAuley, Tugwell, & Moher, 2000), and books were excluded. Publications preceding 1998 were excluded, along with those not published in the English language.

Two Boolean searches were carried out for each listed database. The terms for these searches are outlined in Table 1.

1	Education	{Semi Formal OR Nonformal OR Informal OR outside the classroom OR out of school} AND {Learning OR Education} AND {Science}
2	Extra Curricular	{Extra curricular OR after school OR Maker} AND {Programmes OR Course OR Clubs OR Activities} AND {Science}

Table 1: Boolean search terms for publication databases.

The protocol for selecting the work that was included in the review involved two separate assessors independently determining if a study/publication fit the selection criteria. If there were any studies/publications that were included by one assessor but excluded by the other that piece of work was then reappraised by both of the assessors to make a final decision on whether it should be included or excluded.

3.4   Database Searching

A number of areas were targeted to ensure a comprehensive search was undertaken in line with the recommendations of Papaioannou et al., (2010). These included a series of bibliographic databases outlined in Appendix 1. Once a paper or study was found that fit the search criteria, its reference list was searched as well as any publications that had subsequently cited that work, commonly referred to as the "pearl growing" method (Ramer, 2005). Pearl citations were subjected to the same inclusion and exclusion criteria as outlined. Key individual journals in the research area were explored using the selection criteria. A number of scholars in the field were also contacted for their recommendations of the most important work pertaining to conceptual frameworks for informal learning, as a means of checking the validity of early searches.

A comprehensive list of all included literature has been provided in Appendix 2. Once all the studies had been collected using the inclusion and exclusion criteria and the databases listed above, they were systematically evaluated. This process was documented to ensure that the way in which the studies were collected and assessed was transparent and could be replicated. All of the studies were collected and assessed between July and October of 2018. The first assessment as to whether each study should be evaluated further was by determining its relevance from the title and abstract. If it fell within the defined scope of the review and met the inclusion criteria, then the rest of the publication was examined.

Further examination of these publications qualified it for analysis subject to a further set of inclusion/exclusion criteria. Exclusion criteria included publications whose pearl citations were pre-dating 1998, publications whereby a critique or point of view on a referenced framework was not delivered. Papers whereby informal education evaluation frameworks were provided without adequate definition or reference to an informal education framework were excluded.

Inclusion criteria were where a critique, discussion, or definition of informal, non-formal or any alternative moniker, e.g. free-choice learning, was provided. Non-peer reviewed publications that were repeatedly referenced were considered for inclusion.

4. Results

4.1   Conceptual Frameworks

The studies that met the inclusion criteria were appraised and indexed (as shown in Table 2) by: title of the study, the year of its publication or release, the country where the work was carried out, the main purpose of the work or why it was undertaken, any explicit details about the methodology and whether it results in an empirical or theoretical study, comments from the review team, and the full academic reference and link to the study (where available).

Title	Year	Country	Journal	Approach	Reference (APA)
"Some Explanation Here": A Case Study of Learning Opportunities and Tensions in an Informal Science Learning Environment	2017	US	Instructional Science	Empirical	Stewart, O. G., & Jordan, M. E. (2017). "Some explanation here": a case study of learning opportunities and tensions in an informal science learning environment. Instructional Science, 45(2), 137-156.
A Non-Formal Student Laboratory as a Place for Innovation in Education for Sustainability for All Students	2015	Germany	Education Sciences	Empirical	Affeldt, F., Weitz, K., Siol, A., Markic, S., & Eilks, I. (2015). A non-formal student laboratory as a place for innovation in education for sustainability for all students. Education Sciences, 5(3), 238-254.
Benefits of Informal Learning Environments: A Focused Examination of STEM-based Program Environments.	2015	US	Journal of STEM Education	Empirical	Denson, C., Austin, C., Hailey, C., & Householder, D. (2015). Benefits of informal learning environments: A focused examination of STEM-based program environments. Journal of STEM Education, 16(1).
Beyond the Classroom Walls: Technology Infusion Advancing Science Education	2016	US	Delta Kappa Gamma Bulletin	Theoretical	Ponners, P., & Asim, S. (2016). Beyond the Classroom Walls: Technology Infusion Advancing Science Education. Delta Kappa Gamma Bulletin, 83(1), 61.
Bridging in-school and out-of-school learning: Formal, non-formal, and informal education	2007	Israel	Journal of Science Education and Technology	Theoretical	Eshach, H. (2007). Bridging in-school and out-of-school learning: Formal, non-formal, and informal education. Journal of science education and technology, 16(2), 171-190.
Competencies of Science Centre Facilitators	2015	Turkey	Journal of Turkish Science Education	Empirical	WAN, W. N. F., Fairuz, M., Syukri, M., & Halim, L. (2015). Competencies of science centre facilitators. Journal of Turkish Science Education, 12(2).
Developing Non-Formal Education Competences as a Complement of Formal Education for STEM Lecturers	2018	Mexico	Journal of Education for Teaching	Empirical	Terrazas-Marín, R. A. (2018). Developing non-formal education competences as a complement of formal education for STEM lecturers. Journal of Education for Teaching, 44(1), 118-123.
Eight-Legged Encounters-- Arachnids, Volunteers, and Art	2018	US	Insects	Empirical	Hebets, E. A., Welch-Lazoritz, M., Tisdale, P., & Wonch Hill, T. (2018). Eight-Legged Encounters—Arachnids,

help to Bridge the Gap between Informal and Formal Science Learning.					Volunteers, and Art help to Bridge the Gap between Informal and Formal Science Learning. Insects, 9(1), 27.
Enacting Informal Science Learning: Exploring the Battle for Informal Learning	2016	UK	British Journal of Educational Studies	Empirical	Clapham, A. (2016). Enacting informal science learning: exploring the battle for informal learning. British Journal of Educational Studies, 64(4), 485-501.
Everyday Scholars: Framing Informal Learning in Terms of Academic Disciplines and Skills	2010	Canada	Adult Education Quarterly	Theoretical	Jubas, K. (2011). Everyday scholars: Framing informal learning in terms of academic disciplines and skills. Adult Education Quarterly, 61(3), 225-243.
Formal, Nonformal and Informal Coach Learning: A Holistic Conceptualisation	2006	UK	International Journal of Sports Science & Coaching	Theoretical	Nelson, L. J., Cushion, C. J., & Potrac, P. (2006). Formal, nonformal and informal coach learning: A holistic conceptualisation. International Journal of Sports Science & Coaching, 1(3), 247-259.
Informal and Non-Formal Education: An Outline of History of Science in Museums	2014	Greece	Science & Education	Theoretical	Filippoupoliti, A., & Koliopoulos, D. (2014). Informal and non-formal education: An outline of History of Science in museums. Science & Education, 23(4), 781-791.
Informal science education: Lifelong, life-wide, life-deep.	2014	US	PLOS Biology	Theoretical	Sacco, K., Falk, J. H., & Bell, J. (2014). Informal science education: Lifelong, life-wide, life-deep. PLoS biology, 12(11), e1001986.
Integrating Academic and Everyday Learning Through Technology: Issues and Challenges for Researchers, Policy Makers and Practitioners	2018	UK	Technology, Knowledge and Learning	Theoretical	Lewin, C., Lai, K. W., van Bergen, H., Charania, A., Ntebutse, J. G., Quinn, B., ... & Smith, D. (2018). Integrating Academic and Everyday Learning Through Technology: Issues and Challenges for Researchers, Policy Makers and Practitioners. Technology, Knowledge and Learning, 23(3), 391-407.
Integrative Literature Review on Informal Learning: Antecedents, Conceptualizations, and Future Directions	2018	US	Human Resource Development Review	Theoretical	Jeong, S., Han, S. J., Lee, J., Sunalai, S., & Yoon, S. W. (2018). Integrative Literature Review on Informal Learning: Antecedents, Conceptualizations, and Future Directions. Human Resource Development

					Review, 17(2), 128-152.
Introducing Future Teachers to Science Beyond the Classroom	2013	US	Journal of Science Teacher Education	Empirical	Kisiel, J. (2013). Introducing future teachers to science beyond the classroom. Journal of Science Teacher Education, 24(1), 67-91.
Learning in a personal context: Levels of choice in a free choice learning environment in science and natural history museums.	2007	Israel	Science Education	Empirical	Bamberger, Y., & Tal, T. (2007). Learning in a personal context: Levels of choice in a free choice learning environment in science and natural history museums. Science Education, 91(1), 75-95.
Mapping the informal science education landscape: An exploratory study	2011	US	Public Understanding of Science	Empirical	Falk, J. H., Randol, S., & Dierking, L. D. (2012). Mapping the informal science education landscape: An exploratory study. Public Understanding of Science, 21(7), 865-874.
Non-formal and Informal Science Learning: Teachers' Conceptions.	2014	Greece	International Journal of Science and Society	Empirical	Sevdalis, C., & Skoumios, M. (2014). Non-formal and Informal Science Learning: Teachers' Conceptions. International Journal of Science in Society, 5(4).
Non-formal education: a major educational force in the postmodern era	2009	Israel	Cambridge Journal of Education	Theoretical	Romi, S., & Schmida, M. (2009). Non-formal education: a major educational force in the postmodern era. Cambridge Journal of Education, 39(2), 257-273.
Nonformal and Informal Adult Learning in Museums: A Literature Review	2008	US	Journal of Museum Education	Theoretical	Dudzinska-Przesmitzki, D., & Grenier, R. S. (2008). Nonformal and informal adult learning in museums: A literature review. Journal of Museum Education, 33(1), 9-22.
Reframing research on informal teaching and learning in science: Comments and commentary at the heart of a new vision for the field	2014	US	Journal of Research in Science Teaching	Theoretical	Rahm, J. (2014). Reframing research on informal teaching and learning in science: Comments and commentary at the heart of a new vision for the field. Journal of Research in Science Teaching, 51(3), 395-406.
Research Trends and Findings From a Decade (1997-2007) of Research on Informal Science Education and Free-Choice Science Learning	2010	US	Visitor Studies	Empirical	Phipps, M. (2010). Research trends and findings from a decade (1997–2007) of research on informal science education and free-choice science learning. Visitor studies, 13(1), 3-22.

School and out-of-school science: a model for bridging the gap	2013	UK	Studies in Science Education	Theoretical	Fallik, O., Rosenfeld, S., & Eylon, B. S. (2013). School and out-of-school science: A model for bridging the gap. Studies in Science Education, 49(1), 69-91.
Science Education through Informal Education	2016	US	Cultural studies of science education	Theoretical	Kim, M., & Dopico, E. (2016). Science education through informal education. Cultural studies of science education, 11(2), 439-445.
Science learning through scouting: an understudied context for informal science education	2005	UK	International Journal of Science Education	Empirical	Jarman, R. (2005). Science learning through scouting: an understudied context for informal science education. International Journal of Science Education, 27(4), 427-450.
So You Want to Share Your Science …. Connecting to the World of Informal Science Learning.	2018	US	Integrative and Comparative Biology	Theoretical	Alpert, C. L. (2018). So you want to share your science…. Connecting to the world of informal science learning. Integrative and comparative biology.
STEM Clubs and Science Fair Competitions: Effects on Post-Secondary Matriculation	2013	US	Journal of STEM Education	Empirical	Sahin, A. (2013). STEM clubs and science fair competitions: Effects on post-secondary matriculation. Journal of STEM Education, 14(1), 5-11.
Summer science camp for middle school students: A Turkish experience	2013	Turkey	Journal of Turkish Science Education	Empirical	SEZEN VEKLİ, G. (2013, April). Summer science camp for middle school students: A Turkish experience. In Asia-Pacific Forum on Science Learning & Teaching (Vol. 14, No. 1).
Tap Into Informal Science Learning	2000	US	Science Scope	Theoretical	Melber, L. M. (2000). Tap Into Informal Science Learning. Science Scope, 23(6), 28-31.
The 95 Percent Solution	2010	US	American Scientist	Theoretical	Falk, J. H., & Dierking, L. D. (2010). The 95 percent solution. American Scientist, 98(6), 486-493.
The Missing Link to Connect Education and Employment: Recognition of Non-Formal and Informal Learning Outcomes	2012	France	Journal of Education and Work	Theoretical	Werquin, P. (2012). The missing link to connect education and employment: recognition of non-formal and informal learning outcomes. Journal of Education and Work, 25(3), 259-278.

The Opinions of Science and Technology Teachers Regarding the Usage of Out-Of-School Learning Environments in Science Teaching	2015	Turkey	Journal of Turkish Science Education	Empirical	TOPALOĞLU, M. Y., & KIYICI, F. B. (2015). The Opinions of Science and Technology Teachers Regarding the Usage of Out-Of-School Learning Environments in Science Teaching. Journal of Turkish Science Education (TUSED), 12(3).
The Organization of Informal Learning	2016	US	Review of Research in Education	Theoretical	Rogoff, B., Callanan, M., Gutierrez, K. D., & Erickson, F. (2016). The organization of informal learning. Review of Research in Education, 40(1), 356-401.
The Relationship between Formal Education and Non-Formal Education: A Descriptive and Analytical Review of the Publications about Astronomy Education in Journals and Events Related to Science Teaching in the Brazilian Context	2018	Brazil	Science Education International	Empirical	Menezes, I. M. C. A., Ovigli, D. F. B., & Colombo Jr, P. D. (2018). The Relationship between Formal Education and Non-Formal Education: A Descriptive and Analytical Review of the Publications about Astronomy Education in Journals and Events Related to Science Teaching in the Brazilian Context. Science Education International, 29(1), 11-19.
The roles of the formal and informal sectors in the provision of effective science education	2010	AUS	Studies in Science Education	Theoretical	Stocklmayer, S. M., Rennie, L. J., & Gilbert, J. K. (2010). The roles of the formal and informal sectors in the provision of effective science education. Studies in Science Education, 46(1), 1-44.
Transforming Elementary Science Teacher Education by Bridging Formal and Informal Science Education in an Innovative Science Methods Course	2010	US	Journal of Science Education and Technology	Empirical	Riedinger, K., Marbach-Ad, G., McGinnis, J. R., Hestness, E., & Pease, R. (2011). Transforming elementary science teacher education by bridging formal and informal science education in an innovative science methods course. Journal of Science Education and Technology, 20(1), 51-64.
Using Science Centers and Museums for Teacher Training in Turkey	2013	Turkey	The Asia-Pacific Education Researcher	Empirical	Tasdemir, A., Kartal, T., & Ozdemir, A. M. (2014). Using science centers and museums for teacher training in Turkey. The Asia-Pacific Education Researcher, 23(1)

Table 2: Publications analysed for theoretical informal science education frameworks

4.2   Limitations

Similar to the warnings of Booth, Sutton, and Papaioannou (2016), the greatest constraints on this systematic review, were those of time, resources, expertise, audience/purpose, and data (p. 37-38). Moreover, the results that were returned from the queries represent recent practices on the field, and theoretical approaches based on these practices; however, no pure policy-based databases were searched for definitions and frameworks. These limitations stem from the scope of WP2, which is focused on mapping current practice and reflect upon it, as opposed to review the policy landscape. An additional limitation resulting from the above is the geographical spread of the empirical evidence, as some countries or regions had more results in the queries than others. In addition, several of the results were focused on areas other than the ones SySTEM 2020 is interested in, such as teacher training, and thus had no indication of how their framework might be inclusive for diverse learner groups.

5. Discussion and Conclusions

5.1   Definitions of Terms

The following points can be raised as a result of the systematic literature review.

There is not a high degree of consistency in how terms are defined in the field. "Formal" and "informal" science learning are mostly consistent but there is not complete agreement between what the differences are between "informal" and "non-formal". Terms like "Semi-formal" are sometimes also used (see OECD report), but not widely.

Several papers mention frameworks that are often shaped or tweaked to fit the purpose of the activity being discussed. This indicates the need for a flexible and mobile framework that can span several situations, as frameworks can be optimised for each context.

There is no clear and obvious existing framework that we think the SySTEM project should use from the literature. As SySTEM 2020 will span several contexts, on the one hand it does need to bridge the variety of the contexts, and thus the definitions, but on the other hand it also needs to provide the required inclusiveness for various contexts, within the caveats of the limitations mentioned above.

Building on these frameworks SySTEM 2020 proposes the definitions for formal and informal science learning as presented by the National Centre for Vocational Education Research of Australia (NCVER 2013/17). The definitions were picked for their universality, i.e., their vertical and horizontal mobility and inclusiveness with regard to topics, subjects, levels, and contexts. That is, these definitions are functional for a variety of ages, countries, activities, abilities, and STEM topics.

	Formal	Informal	Non-Formal
NCVER (2013/17)	Learning that takes place through a structured program of instruction which is generally recognised by the attainment of a formal qualification or award (for example, a certificate, diploma or degree).	Learning resulting from daily activities related to work, family or leisure. It is not organised or structured (in terms of objectives, time or learning support). Informal learning in most cases is unintentional from the learner's perspective. It typically does not lead to certification.	Any organised and sustained educational activity that does not correspond exactly to the definition of formal education. Non-formal education may therefore take place both within and outside educational institutions, and cater to persons of all ages.

Table 3: NCEVER (2013/17) Definitions

It is interesting to compare the definitions from the literature review, and the selected working definition, with a definition presented by the European Commission:

- **Formal learning** – learning that occurs in an organised and structured environment (e.g. in an education or training institution or on the job) and is explicitly designated as learning (in terms of objectives, time or resources). Formal learning is intentional from the learner's point of view. It typically leads to validation and certification.
- **Non-formal learning** – learning which is embedded in planned activities not always explicitly designated as learning (in terms of learning objectives, learning time or learning support), but which contains an important learning element. Non-formal learning is intentional from the learner's point of view. It can take place in museums, science camps/ clubs etc.
- **Informal learning** – learning resulting from daily activities related to work, family or leisure. It is not organised or structured in terms of objectives, time or learning support. Informal learning is mostly unintentional from the learner's perspective. (Fehringer, 2018).

While the NCVER and the EC definitions have many similarities, a striking difference is that for the EC the designation of an activity as a learning activity is quite decisive in formal learning, and not decisive in non-formal learning, as the activity may be explicitly designated as learning, but not always. Similarly, the EC places importance in the learner's intentionality in all three definitions, while the NCVER makes no claims with regard to the intentions of the learner in two out of the three definitions.

Therefore, even though we have no major disagreement with the EC definitions, we will keep the NCVER's ones as our working definitions. As the project focuses on learning outside the classroom, we are interested in the definitions of informal and non-formal learning in themselves as much as we are interested in their contrast with formal learning. While both sets of definitions use qualifiers such as "mostly", "in most cases", "generally", and so on, and thus do not result in clearly distinctive definitions but include blurred lines, the language of NCVER that talks about institutions, age groups, instruction, and qualifications, matches better our project which strives to identify criteria for fair inclusion in science learning outside the classroom.

5.2   Recommended Conceptual Framework

Having reached a conclusion about the definitions of formal, informal, and non-formal education, it is useful now to consider it within the scope of SySTEM 2020. As its scope is around science education outside the classroom, it seems that the differentiation between informal and non-formal education is not a sufficient condition to identify initiatives that may be included in SySTEM 2020 activities. Therefore, we recommend to construct a conceptual framework by looking at various **attributes** and **dimensions** of informal and non-formal education as found in the literature review.

The main identified attributes, according to the literature review, are as follows:

1. Learning objectives

This attributes refers to the learning planning process from the point of view of the learning institution. The institution may have planned specific learning objectives for the learners, or identified broader, non-specific goals.

- Formal learning **has** learning objectives
- Informal learning **does not have** learning objectives
    - but may have a goal
- Non-formal learning **has** specific learning objectives

Often **a combination of processes** is applied in practice.

2. Intention

This attribute discusses the intentionality or not with regard to learning from the learner's point of view. Literature did identify that intention may be oriented towards a goal (i.e. compliance) rather than learning itself.

- Formal learning **is** intentional from the learner's point of view
- Informal learning **may or may not be** intentional (generally **not**)
- Non-formal learning **is** intentional
- The **purpose** of the intention can be political is several contexts (i.e. a government requiring specific content)

3. Qualification

The literature review did not make a distinction between credentialisation and accreditation, therefore the more generic term 'qualification' is used here. The information gathering during the mapping tasks of the WP may reveal better what the practitioners perceive as such.

- Formal learning **does** lead to a qualification
- Informal learning **does not** lead to a qualification
- Non-formal learning **does not** lead to a qualification
- The OECD have suggested learning objectives as a **metric** instead of qualifications

We recommend an inclusive practice, which will record each attribute for each initiative, and will include all but the ones that have {Learning objectives **AND** are intentional **AND**

lead to qualification}. We expect that this will allow for the maximum horizontal and vertical mobility of the framework.

As dimensions of the activities can be considered the following: is the activity taking place in a formal institution (i.e. is it a library that is organising an informal STEAM day); is STE(A)M the institution's main occupation; is the activity, even informal, connected to a curriculum; is there planning for inclusion and accessibility; is there planning for capturing and/or assessing learner competencies; and others that will be determined by the information gathering for the map-related tasks of WP2.

The dimensions and attributes are to be conceived as a matrix, where each activity will have its own matrix, and it may comply with several attributes per dimension—ideally each activity will contain information for all attributes, but as not all dimensions are known, some are anticipated to be more relevant to all attributes while others only to one or two. It will be assigned as formal, non-formal, or informal for each dimension and attribute. Initiatives that have {Learning objectives **AND** are intentional **AND** lead to qualification} for all dimensions will not be considered to be within the scope of this project, while cases with mixed formal and non-formal or informal attributes will.

For example, a library may organise STE(A)M activities where they consider capturing information about the learners' competencies (e.g. by a creativity-focused learning portfolio), which is a dimension of this framework. Within this dimension, they may be considering non-formal learning objectives (planned but not tied to an official curriculum), they may be formal or non-formal concerning learners' intentions with regard to creativity—i.e., they may plan to deliberately inspire creative thinking by learners—(two attributes ticked for this dimension), and may be qualifications informal or non-formal with regard to qualifications—i.e., they may include a qualification for attendance, but not for the dimension of creativity—(two attributes ticked for this dimension).

5.3   Implications

The aforementioned recommendation has a series of implications for the project, practitioners, and policy makers.

Firstly, the framework itself is agnostic to defining non-formal or informal education; processes within it may still use the distinction should it be useful for a task at hand (i.e. grouping or communications), but the distinction is not required.

The framework again lets to practice decide additional dimensions: for example, soft skills (often called 21st century skills) such as creativity, collaboration, or communication, can be added as a dimension to the above attributes and be measured at will. Often the existence of such cognitive behaviours, such as the aforementioned skills or engagement and motivation, has no proven benefits to knowledge retention itself, but may still be beneficial for the learners in their ecosystem.

Similarly, qualifications and metrics may be understood in a way that is new and complements the common definition as derived from the literature. In literature qualifications was almost always understood as a combination of credentialing and accreditation, while the two can be potentially separated.

Overall, as several attributes are not necessary and sufficient to define either formal, informal, or non-formal learning, flexibility and inclusiveness seem to be adequate working principles. While this flexibility may create a 'bottom-up' fluidity as opposed to classifying initiatives 'top-down' in rigid categories, and this fluidity can be seen as confusing, it also allows for an inclusive categorisation with attributes that matter as much in themselves, as also in their combinations.

In practical project terms, the implications most significantly converge to the point of requiring information gathering concerning the situation *in situ* with regard to specific programmes. This document will be updated taking advantage of Tasks 2.2 and 2.3 which will gather information about specific initiatives in order to map thousands of European initiatives. This information will help elucidate how the identified attributes from the literature review appear in practice and, thus, how they can be criteria for excluding or including initiatives as informal or non-formal.

5.4   Future Work

Several areas are marked as requiring future work during the duration of the project. Firstly, as the scope of this document was to conduct a literature review and derive a conceptual framework concerning formal, informal, and non-formal education, it has not conducted an analysis of specific parameters of the papers such as specific demographics or pedagogical practices. This analysis will be useful for several WPs in SySTEM 2020. Additionally, outlining the areas of further work of the reviewed papers in order to identify future research directions will be interesting to SySTEM 2020, as there was little consensus in the articles about areas to be explored further: a comparative analysis between this outline and our proposed approach can inform us about the project. In addition, the actual use of the defined attributes and the additional dimensions that consist the framework as a practice in the SySTEM 2020 project need to be defined, and refined in an iterative fashion throughout the lifecycle of the project.

Out of the 5 objectives set out at the beginning of this paper, the current deliverable fulfils the first three, while it leaves the last two as future work. That is, the deliverable conducted a literature review of the existing informal science education frameworks in Europe, it outlined the current frameworks of informal science education research and identified existing gaps and definitions mismatch, and it constructed a categorisation technique to employ on existing frameworks for informal science education programmes. Throughout the project, it will continue to identify current strengths and challenges faced by existing informal science education programmes, and propose a comprehensive framework for informal science education programmes, enriched with information the project receives from other tasks in WP2.