# Chapter 10
# Sweden, Australia, and Belgium: STEM Comparisons in Early Childhood


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**Abstract** Internationally, there has been an ongoing focus by governments through their educational policies to address declining interest in Science, Technology, Engineering and Mathematics (STEM). This increasing need for knowledge and understanding of STEM provides an impetus for all educational systems to re-visit their actions around STEM learning and engagement. A more comprehensive understanding of early childhood STEM education provision is needed so that an informed, effective, and appropriate development of early childhood STEM pedagogical standards and resources occurs. This chapter provides research to understand what cultural influences are brought into play as teachers work in STEM education, what they do when teaching STEM and the factors which influence their decision making. Examples from three countries, Sweden, Australia, and Belgium, are explored using document analysis and qualitative data to formulate their cases. The three cases studies were considered from the perspective of education policy, provision of teacher education, and teaching practice. Examination of the practices that are currently in place in Sweden, Australia and Belgium provide information that the policy and

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cultural background of each country contribute to strong similarities and but also relatively small differences in teacher pedagogy.

**Keywords** Early childhood · Policy · Curriculum · Cultural influences · Pedagogy

## 10.1 Introduction

Science, Technology, Engineering and Mathematics (STEM) is at the forefront of both government and educational policies at an international level. With a current recognition of the declining interest in these areas, yet the increasing need for knowledge and understanding of STEM, there is an impetus for all educational systems to re-visit their actions around STEM learning and engagement. Young children's understanding of the world around them is one of the strongest predictors of their later science, mathematics, and literacy learning (Grissmer et al., 2010), yet many young children have few opportunities to engage in STEM learning (Early et al., 2010; Greenfield et al., 2009). STEM learning needs to occur in early childhood is considered internationally to mean children from birth to eight years of age.

Research into early childhood STEM is limited (see, for example, Campbell et al., 2018; Tippett & Milford, 2017). EC STEM research is not widely distributed, nor well integrated into existing programs at early childhood centres such as preschools. Important areas which need further investigation if we are to achieve a goal of effective practice in early childhood STEM include research that identifies the children's STEM capabilities and teaching practices or experiences that enhance children's learning in and across the STEM areas.

To support the development of STEM understandings in early childhood, we need to understand what is currently happening in early childhood centres. We cannot consider how to better prepare educators if we do not know what they do. We cannot develop resources or standards without a much better understanding of what is happening in our early childhood centers and preschools in regard to children's STEM learning and teachers' STEM pedagogy. Our investigations across the three countries centred on what early childhood teachers do to teach STEM, what strategies they used, how they enhanced children's existing understandings and how they developed their own professional learning. This chapter uses three Case Studies from Sweden, Australia, and Belgium to investigate existing STEM learning experiences and interrogate these experiences in terms of their ability to help children develop meaningful STEM understandings.

## 10.2 Selection of Cases

This chapter's authors, from Sweden, Australia and Belgium, were attending a large European early childhood conference of approximately 2500 delegates and theirs

were the only specific STEM presentations. At each of their presentations, the questions raised led us to believe that synergies existed across the different research studies. Our curiosity was piqued as we sought to better understand each other's research. A meeting to discuss the different research results and to decide whether the similarities or differences were valuable to report took place. All studies approached the research aware that large-scale research in STEM in early childhood was not well reported. We wanted to draw together three different sets of data and examine the complementarity of each data set. There was an understanding that the three studies were seeking answers to broad questions rather than proposing theoretical positions. Immediately, synergies were apparent as the questions posed to early childhood teachers were similar. We hoped that this would be of interest to other international contexts seeking to understand this issue and that our study in a field, which remains under-researched, would provide others a baseline to apply to their own situation.

Sweden, Australia and Belgium provide interesting cases to study. They exhibit a range of similarities and differences. Culturally, all countries are regarded as 'individualistic' (Hofstede, 2021) that is, each individual and their needs are prioritised over the entire group or its needs. Individualistic cultures are oriented around the self, being independent (Hofstede, 2021). This relates strongly to the ideas surrounding the development of each individual in the education system and the way that education strategies relate to children as learners. Despite differences in language, there are similarities with each government's policy focus on STEM, and STEM education. We examined and found clear consistencies between key measures in education such as TIMSS (Sweden mathematics 510/science 540; Australia 517/524; and Belgium 546/512) and PISA (Sweden 25-495, Australia 21-502.2 and Belgium 20-502). These speak to not only the similarity between each country but also it allowed us to interrogate more closely what potential differences exist.

## 10.3 Country Contexts

To understand each of the three Case Studies in Sweden, Australia and Belgium, some background is provided in relation to the place of early childhood in national curriculum, how policy directs local provision, and teacher qualifications/education, sourced through policy documents and websites in each country.

| **SWEDEN** |
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| **EC in national curriculum—**The National Agency for Education is the central national administrative authority for the school system. Preschool is the first stage in the *Swedish educational* system. Preschool education is governed by the Education Act and the national curriculum specified by the Swedish National Agency. The national curriculum describes the preschool values, goals to strive for and educational tasks for the preschool staff. It is voluntary and includes educational activities for children aged one to five years old. At age six children attend mandatory preschool class. After one year in preschool class, the children continue through a nine-year compulsory school system |

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**Policy directs local provision—**Teaching approaches depend on local culture, resources and the teacher's selected curriculum goals. Preschool is intended to lay the foundation for lifelong learning and should, according to the national curriculum, be fun and interesting for all. Children should have the opportunity to learn through play, to create and to explore on their own, in groups or together with adults. The preschool teachers are responsible for education, and together with the other staff, the preschool should promote the children's development and learning. Preschool teaching can be indoor or outdoor. The National Curriculum emphasizes that time spent outdoors should provide opportunities for play and other activities, both in planned and natural environments (National Agency 2016, p. 7)

**Teacher qualifications/education—**Preschool teacher undertake three and a half years of full-time study at university level with a bachelor's degree. There is one education program for all preschool teachers with local differences across universities. The education includes courses in science, technology and mathematics, besides other knowledge areas. During their education degree, students undertake a 20-week internship in preschool divided into three periods supervised by *local teacher educator* and university academics. Not all preschool *staff* are trained teachers. The National Agency for Education ensures that Swedish education maintains a good standard of quality and achieves this with the help of national school development programs and in-service training of the staff. The agency issues diplomas of certification to preschool teachers. The National Agency for Education prepares knowledge requirements and general recommendations. They are responsible for official statistics in the area of education and conduct national follow-ups and evaluations. In-service teachers have opportunities to attend other courses at university level for example five-week courses. These courses can be assignment courses ordered by the National Agency of Education and can include courses in science, mathematics, and technology or in language and multilingualism. The municipalities also support the preschool teacher's professional learning and offer opportunities to attend lectures in different topics

**AUSTRALIA**

**EC in national curriculum—**Education is both a federal and a state issue. The federal government provides funding to the states, but the states must also use their own budgets to fund preschools. Early childhood education, birth to five years old, is not compulsory. Preschool education (frequently called kindergarten) occurs in the year prior to formal primary education and is delivered by both childcare centres (privately owned and managed) and government preschool centres. Children are nominally four to five years of age during preschool. Preschool programs are funded by government for 15 h each week. Children younger than aged four to five can attend a three-year-old 'kinder' but this is privately funded by parents. *The Early Years Learning Framework* (EYLF, DEEWR 2009), are guidelines that teachers can access, however, there is no mandated curriculum to be followed. The Framework is designed to outfit teachers with common language about children's learning and stipulates five learning outcomes for young children around identity; connected to their world; wellbeing; confident and involved learners; effective communicators

**Policy directs local provision—**The EYLF learning outcomes provide a broad direction. Autonomy is provided to the teacher to design curriculum specific to the local community and specific setting beliefs and policy. The preschool day is usually divided into short segments with time spent both inside with more structured materials and outside with most preschools having an outside area which is designed to be as natural as possible, but will also contain features such as a digging area (sand pit), grassed area (for movement), water troughs and outside toys. Many kindergartens now offer three to five hours in an outside 'bush' or natural environment each week

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| **Teacher qualifications/education—**Early childhood teachers must complete a four-year university undergraduate bachelor's degree. This is usually a bachelor's degree in early childhood studies or early years in which STEM is often represented in pedagogical discipline studies of science, technology, mathematics. In recent years, the bachelor's degree has been adapted to provide educational coverage for children from birth to age 12 (early childhood and primary teaching). The label of 'teacher' differentiates a four-year educated person from someone who qualifies with a three-year diploma (Technical and Further Education Institute—TAFE) or a two-year certificate (TAFE). These lesser qualifications designate a trained person as an 'educator'. Trainee teachers and educators spend time in preschool setting as interns for approximately 80 days. In preschools, a qualified teacher will lead the four- to five-year-old program, while trained educators will work with the birth to three-year-old children. There are minimal additional training sessions or professional learning opportunities in the STEM areas for early childhood educators or teachers to attend |
| **BELGIUM** |
| **EC in national curriculum—**Belgium is a federal state, composed of three communities (Flemish, French and German-speaking communities) and three regions (Flemish Region, the Brussels-Capital Region, and the Walloon Region). The power to make decisions no longer belongs exclusively to the federal government. The Flemish, French and German-speaking Community are autonomous in the field of education overseen by the federal government. The Flemish Government is fully responsible for the organization of education in Flanders across primary education (including preschool), secondary education and higher education. Preschool education for children from two and a half to six years, is not compulsory. At the age of six, a child usually moves to primary school, which is compulsory and undergoes six years of study, obtaining their first diploma: the certificate of primary education. This certificate enables the transition to secondary education<br>There are six learning areas in preschool education: (1) physical education; (2) musical education; (3) Dutch language; (4) people and society; (5) science and technology; (6) mathematical initiation. Development goals for preschool education are knowledge, insight, skills and attitudes. With these development goals, the Flemish government determines the social mission of every school |
| **Policy directs local provision—**The school and the parents know the required minimum standards. Each school and teacher can freely design their own curriculum content. The preschool teachers place the children in powerful and rich learning environments where the children take their own learning into their own hands. Children have opportunities to develop competencies in situations that are realistic for them, learning from their environment or during the exploration of another person's world. Teachers focus on cognitive, motor and social-emotional aspects and challenge children to actively learn, to solve problems collaboratively, to organise themselves, and to explain their own methods |
| **Teacher qualifications/education—**Education for preschool teachers is conducted during three years of full-time studies at a university college (Professional bachelor's degree). Preschool teachers obtain a degree of Bachelor of Education: Preschool (Pre-primary) |

## 10.4 Comparing the Research Designs

The research designs of all three studies were based on collecting qualitative data, relying on collection methods such as surveys and in some cases teacher and educator

observations and interviews. The aim of each study was similar in terms of locating knowledge about STEM practices in early childhood. The three research studies were conducted in 2016 in Sweden and Australia, and in 2017 in Belgium. See Table 10.1 for an overview of data collection methods.

Sweden developed a research design that combined different ways of constructing data over time. The survey collected demographic data and information regarding STEM knowledge and curriculum goals. STEM pedagogy/didactics and the subsequent analysis pointed to the need to deepen knowledge of preschool teachers' work with STEM areas in their child groups. Interviews were informed by the survey results. The survey and interview questions were underpinned by key ideas that included *preschool teachers' knowledge* of STEM education and teaching objectives/goals as well as *pedagogical content knowledge* focusing on developing children's learning in STEM areas. The interview, questions considered topics including how teachers challenge children to develop mathematical (scientific and technological) ability and how teachers learn from children's previous knowledge. Other questions considered children's feedback and the use of children's own questions and the teachers' perceived challenges in their teaching.

Researchers in the Australian study undertook site visits to observe instances of STEM teaching and learning. Four preschool settings were visited weekly for six weeks and observational data recorded visually through electronic means (ipads) and through researcher journal notes. The effectiveness of preschool teachers' early childhood STEM pedagogy and how teachers engage children's learning in STEM were considered. The four sites provided opportunities for comparison. In 2016, in addition to the research visits to preschools (4–5 years old), an online survey was conducted with teachers from three different Australian states. Despite widespread distribution, only 26 responses were received. The questions of the survey were underpinned by three key ideas: *teachers' knowledge* of STEM as a learning area

**Table 10.1** Overview of data collection methods used

| | Aim | Survey | Observation | Interviews |
|---|---|---|---|---|
| Sweden | to build knowledge of preschool teachers' teaching, content knowledge and pedagogical content knowledge | Yes (300 teachers) | | Yes (10 teachers) |
| Australia | to examine how preschool teachers undertake early childhood STEM pedagogy and teaching practice and how teachers engage children's learning in STEM | Yes (26 teachers) | Yes (40 visits) | |
| Belgium | to examine preschool teachers' familiarity with STEM education, focussing on teachers' knowledge about the STEM domain and pedagogy, planning and organizing STEM lessons, and identifying teachers' needs for support in relation to STEM | Yes (46 teachers) | | |

and pedagogy, teachers' beliefs regarding *children's learning* through engagement in STEM, and teachers' *planning and programming* practices in relation to STEM.

The Belgium researchers were preparing a STEM education professional learning program for preschool teachers. To inform the development of their program, they sought background information on the extent of familiarity that Belgian preschool teachers had with STEM education. They planned their survey questions around teachers' knowledge about the STEM domain and pedagogy, their planning and organization of STEM lessons, and to identify teachers' needs for support in relation to STEM.

## 10.5 What the Teachers Were Saying

From the three different countries, teachers' perceptions were gained in relation to STEM teaching, content knowledge, pedagogical content knowledge, planning and children's engagement. The following sections give an overview of what teachers said in each of the jurisdictions.

### *10.5.1 Sweden*

In Sweden, the study shows that preschool teachers highly value having knowledge about common core values as described in the Swedish national curriculum for preschool. Common core values are, for example, values as democratic, norms and ethics. This is demonstrated in the interviews where the preschool teachers value knowledge of the children's interest as important starting points in the choice of content and work methods during teaching, and that they value their own knowledge of being able to use the children's interest and experience in teaching as significant.

> You catch the children's interest in the moment; you lie on the "car mat" on the floor with and play with a child "here the car rolls fast on the floor, but slowly here on the car mat, why is it like that"?

Preschool teachers based the teaching on the children's interest and experience in mathematics and science but indicated that this was less common for technology teaching.

> When we started using technology, there were many colleagues who were uncertain about how they would do. Then I found some books on the internet and asked the boss to order books for us. Then we could talk about how we would do and give examples, go technical hunting and some such stuff.

In the interviews, the preschool teachers discussed the importance of the activities being fun for children and being carried out according to children's wishes. According to the preschool teachers, this means that the teaching can take place in different

contexts and by different methods, as governed by children's requirements. One of the preschool teachers describes that together with children, they look for simple technologies exhibited in the everyday object.

> We walk around the department and look at everyday technology, we look at the pedal bucket, how to open and close it, how to open and close a door and on the boot.

The teachers say that it is therefore important to vary the environment and context of teaching in order to inspire and challenge the children in these subject areas.

Preschool teachers describe their knowledge, and awareness of the curriculum goals when they teach. However, they do not always have the time required to teach based on the curriculum. Pre-prepared teaching materials, such as the NTA (Naturvetenskap och teknik för alla, 2018) and Green Flag (Stiftelsen Håll Sverige rent, 2018), served as support during planning of teaching. By using pre-prepared materials, preschool teachers indicated that they can work with topics such as water, air, light and sound, which leads to the incorporation of chemistry and physics teaching.

> We work with Green Flag and how can water sounds. This means that the children need to explore water, connected to the senses, splashes, dripping or dripping.

The study revealed preschool teachers' beliefs in their ability to formulate objectives for teaching in mathematics and science however they consider their ability to formulate objectives for teaching in technology requires further development. The curriculum focuses primarily on two objectives in technology: give children opportunities to "develop their ability to identify technology in everyday life and explore how simple technology works"; to develop the children's "ability to build, create and construct using different techniques, materials and tools" (National Agency for Education, 2016, p. 10). Preschool teachers have identified a need to develop their ability within teaching, in order to let the children develop their abilities and understanding in technology.

Documentation is an important part of teaching. The documentation can be directed to the children and can be used by the children, for example, for reflection. The children's interest is described as a guiding principle. The preschool teachers also express a willingness to have teaching practice that allows the children to participate and influence the content and form of the activities. This means that the preschool teachers work in a systematic way in order to find out what the children are interested in and how they can continue to work with those areas.

> The children ask questions, for example why does the apple shell disappear first [before other material]? And then we talk about it; that there is so much water in the apple shell and that it is an organic material.

Play and games are an important part of the children's learning in mathematics, science and technology. The play creates opportunities for the preschool teachers to evaluate and see what concepts and notions the children use.

> And then in the free play when the children cook, I saw the other day that a child put a baby doll at each chair and a plate and then one sees "one to one principle".

The analysis of the interviews shows that preschool teachers use both free and the planned play as opportunities for the children to develop an understanding of mathematics, science and technology.

### *10.5.2 Australia*

In the Australian study, across the 200 plus observations noted, there were many different instances of STEM, both as discipline experiences but also as integrated STEM. These were documented using an observation protocol, which recorded the specific experiences, researcher interpretation, educator comment (when available), and other relevant factors important to the play experience. However, what was also noted in the researchers' observation was that teacher scaffolding varied, with some teachers fully involved in children's STEM play experiences, through to situations where the teacher would stand back and watch—unless specifically invited by the child to join in. The support provided to children's STEM play and the preparation of STEM activities in the pre-school was so varied that it was difficult to determine the factors, which underpinned the differences. Teacher pedagogical beliefs played a large part in the quantity and quality of STEM in early childhood centres (see Table 10.2).

The teachers' responses to the survey indicated that STEM was not a term that many of them regularly used or felt they understood well. Some teachers did have a broader understanding of STEM.

**Table 10.2** Selection of observed STEM activities

| STEM—integrated activity | Science concepts | Technology concepts | Mathematics concepts | STEM skills and processes |
|---|---|---|---|---|
| Children building 'cubby houses' using sticks and branches | Forces | Investigate materials, design, construct and evaluate cubby (fit for purpose, aesthetics) | Measuring the branches and sticks | Problem-solving estimation and approximation |
| Weather–undertaking inside discussion, moving outside to observe the weather | Observing –clouds, sky, rain, rainbows (shape, colour, size) | Children creating clouds, rainbows and rain as a room exhibit | Measuring rainfall | Observation measurement, recognising difference in size, shape |
| Whole centre theme on medicine and the human body | skeletons, human body model, | | Measuring bones and aligning them to a template. Measuring body parts comparative | Establishing and justifying sorting criteria |

> It is an integrated approach to teaching Science, Technology, Engineering and Maths.

When discussing their teaching practices, many teachers discussed distinct disciplinary-related practices such as 'inquiry approaches' associated with science and developmental learning appropriate to mathematics.

> …science intentional teaching activities from time to time and more often incidental learning activities. Using a SmartBoard. Providing activities that support children's engineering/mathematical learning.

When asked to describe how they enhanced children's STEM learning, the responses ranged across a number of strategies that were both generic (group learning, teacher-led) but also those considered STEM (demonstrations followed by children experimenting, guided interaction, inquiry-based activities, questioning) (Fig. 10.1).

> I apply the following practices - Inquiry, questioning, provoking and challenging children's ideas, intentionally setting up learning experiences with the purpose to explore a particular idea, scaffolding and suggesting children to explore and discover.

All teachers indicated that learning needed to start with children's interests and prior understanding. Teachers listen to what children say and observe what they do. They can then plan and build children's understanding from there (Fig. 10.2).

> I do this by placing priority on this learning, talking to children about their own learning in this area and acknowledging that everyday experiences can form STEM learning.

Children's engagement and attitudes to STEM were considered very important with teachers indicating their belief that exposure to the STEM disciplines were important for children's later learning in life.

**Fig. 10.1** Teacher-led activity where children were investigating sea animals (sea dragon)

**Fig. 10.2** Intentional teaching of weather and observing clouds

> I'm not sure I would say I'm 'strong' in the STEM area but I try to offer different activities that lend themselves to the Stem concept and build on them from there. I try to be interested and model different behaviours with the activities to promote interest.

Much of the STEM learning was planned and documented with the inclusion of both integrated and specific discipline-focussed activities prepared for the children on a regular basis. These were labelled as science, technologies, construction, mathematics or integrated activities, rather than STEM. All teachers commented that they did include STEM in their program.

> Being intentional and specific with explanations and discussions. Really thinking about the language that we use and demonstrating skills where appropriate.

The teachers acknowledged that planning was difficult, and this seemed contradictory to the idea of child-instigated learning through play.

> Often unsure that I am doing enough in these areas. Often find some staff overlook these areas or think it must be a very structured lesson or a whole group being shown an experiment.

Teachers indicated that additional materials, further professional learning in STEM and greater parent support were amongst the resources they would like to enhance. One of the most significant forms to support STEM learning was listed as *other knowledgeable adults* as well as a particular setting such as bush or natural settings.

> Adults with strong interest in the outdoors and in the environment, lots of outdoor play, multiples of equipment to promote experimenting and discovering, building and trying out new things". "Perhaps further PD opportunities to expand my knowledge as a teacher to be able to know how best to take these topics further.

### *10.5.3 Belgium*

In 2017, a survey was completed by 43 Belgian preschool teachers to examine preschool teachers' familiarity with STEM education. It focused on teachers' *knowledge* about STEM and *pedagogy*, *planning* and *organizing* STEM lessons, and identify teachers' *needs* for *support* in relation to STEM. Data indicated many similarities in the answers of the preschool teachers. There were clear differences in the description of STEM in their own words and it was determined that the meaning of STEM education is not unambiguous. The preschool teachers indicated that they try to plan STEM activities within their daily planning. Observing children's play, listening and talking to children, is crucial to respond to the child's interests. Preschool teachers highlighted that they needed further professional support in order to be able to achieve good STEM education in their daily practice.

Despite the availability of the curriculum documents and the STEM Framework, the analysis of the survey data showed that for preschool teachers 'STEM' is not a frequently used concept. Most teachers referred to domains, mainly science and technology. The integrated work on science, technology, engineering, and mathematics within a STEM activity is mentioned in a few responses. In the definition of 'STEM', preschool teachers often referred to research and design skills that children use in STEM activities: experimenting, discovering, problem-solving, playful experiences. They link activities with computational thinking.

In the survey responses, preschool teachers described that they mainly start from the observations of children's play for the development of STEM activities: the interests of the child form the basis for the choice of teaching methods. Teaching methods cited for STEM activities include asking questions leading to research and design, provoking discussion, and group work. Preschool teachers made a distinction between planned activities and unplanned activities. Working from the interests of the child is important as it provides context -for example, arousing curiosity whereby the child is challenged in a playful way to think for himself, to experiment, to ask questions and to use 'real' material. The offer must be attractive to the children (connection with their environment). These results are also in line with the goals of the STEM Framework where 'STEM wants to learn by means of *real-life* experiences and socially relevant challenges' (Departement Onderwijs en Vorming, 2015, p. 15).

The survey also indicated that preschool teachers could distinguish between, and strive to carry out, planned activities and unplanned activities within a theme: responding to the interests of the children plays an important role here. Preschool teachers indicated that their own knowledge, skills and experiences within STEM education are limited which highlighted that responding to the interests of the children is not easy with every theme. Daring to let go of the children (allowing them autonomy) is also seen as difficult. The demand for professionalization around STEM is high with some stating that there is a 'need' for a handbook with concrete examples. The demand for extra materials and budget to realize STEM education in preschool is also strongly reflected in the surveys.

### *10.5.4 Discussion of the Comparisons Across the Countries*

In comparing the various components for each country against the nominated themes arising from the Swedish study, we found strong similarities and some minor differences. In terms of the policy directions of each country, all countries had policies indicating the importance of education in early childhood, However, Australia did not incorporate STEM learning in the national curriculum.

Teacher practice at the local level tended to be similar, but with some clear differences in the level of detail. For example, while Swedish teachers mentioned linking curriculum goals to the activities, Australian and Belgium teachers did not. This indicates a possible disconnect between the value of learning goals and the planning of activities. The other major difference that was clear in the data from teachers was that documentation of planned activities appeared to be valued by the Swedish teachers, but was not obvious from the Australian or Belgium teachers. There is no data to suggest why this might be, as all curriculum documents from the three participating countries do highlight the need for planning and documentation.

Table 10.3 provides an overview of the results of the comparisons.

**Table 10.3** Comparisons across the countries

| Overview | Sweden—nominated themes | Australian case—supports Swedish case? | Belgium case—supports Swedish case? |
|---|---|---|---|
| National policy and importance | Education is a national issue | Yes | Yes |
| | Early childhood is in the national curriculum | Yes, but STEM is not | Yes |
| | Preschool is mandatory | Yes | Yes |
| Teacher practice at the local level | Teachers use thematic areas | Yes | Yes |
| | Teaching opportunities—spontaneous and random | Yes | Yes |
| | Goals from the curriculum are linked to the activity afterwards | Not specifically mentioned | Not specifically mentioned |
| | Teachers use planned activities and children's interest as important starting points | Yes | Yes |
| | Teachers value activities as fun and being carried out according to children's wishes | Yes | Yes |
| | Teachers vary the environment and context of teaching | Yes | Not specifically mentioned |
| | Teachers value documentation as an important part of teaching | Not specifically mentioned | Not specifically mentioned |

## 10.6 Conclusion

For the teachers in Sweden, Australia and Belgium involved in these studies, there is a strong belief in the autonomy of the child in directing their own learning and in the need to work through children's own play inquiries and interests. Teachers provide learning both through planned and unplanned activities and experiences. However, culturally, one country (Sweden) provided a more prescriptive curriculum document for teachers which enables STEM pedagogy to be more targeted to national requirements. In the Swedish national curriculum document, there appeared to be a stronger focus on 'learning' whereas the other two countries' curriculum documents had a more holistic approach to whole child development.

In relation to qualifications, all countries provided STEM content knowledge in their early childhood degrees. However, this did not translate to similar findings in the teachers' levels of confidence with their own STEM knowledge. The reasons for this are unclear, but may reflect the support for teachers through, either the didactic strength of curriculum documents (e.g. Sweden) or the current Australian State and National government focus on providing additional STEM support in preschools (Australian Government, 2015).

Most of the teachers' discussions highlighted a disciplinary approach to planned STEM activities rather than an integrated approach which could be attributable to the discipline-based teaching teachers received throughout their degree. Integrated STEM approaches are still in their infancy in many countries. Considering that generally children's learning is holistic, a disciplinary approach sits at odds with young children's learning in general. However, as the majority of teachers' time in guiding young children's learning is through scaffolding at the point of need, perhaps this is not a big issue.

Overall, the research findings indicated that the teachers' roles in presenting STEM to the children were very similar and were similarly represented in their discussions. In terms of cross-country comparisons, the evaluation of the three research cases revealed a stronger thread of similarity than difference. The international field of early childhood STEM education providers appear to be taking a comparable pathway forward.

## 10.7 Recommendations

The analysis above highlights that teacher confidence varies across the countries, despite what appears to be comprehensive cover of STEM in qualifications. Further research is required to clarify this difference in teachers' perceptions of their STEM knowledge. Similarly, the data highlighted the disciplinary nature of STEM provision at the early childhood centres which is at odds with the holistic nature of children's learning through play. This points to a need to better understand how an integrated STEM approach might be provided. What specific training do teachers need? Again

further research would clarify future professional learning needs of teachers. Finally, as STEM gains a greater foothold in early childhood curriculum through both planned and unplanned activities, there is a greater need to understand how this is supported by government policies in early learning as well as how it can be implemented successfully in early learning centres.

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