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# **Investigating the effectiveness of subject-integrated school garden teaching**

## **Abstract**

This article maps out existing research regarding the effectiveness of subject-integrated school garden teaching. The school subjects of interest are mathematics, languages and science, and subject integration is defined as a link between these subjects and school garden teaching. The article is based on an integrative review and is derived from existing research, which claims that teaching in school gardens has a predominantly positive influence on students' academic learning outcome. However, experimental studies indicate that some programmes are less effective than more traditional teaching in the subjects concerned. The review extracts and discusses factors that are consistently regarded as vital to ensure the effectiveness of school garden teaching in terms of the integration of mathematics, languages and science. It is concluded that developing a school garden curriculum is essential with a view to planning, carrying out and evaluating subject-integrated school garden teaching. The teaching should include experiential learning and hands-on activities as teaching methods, making the subject content less abstract, stimulating the students' senses, and increasing the feeling of meaningfulness. Furthermore, collaboration across subjects and links between indoor and outdoor teaching are central factors in ensuring the effectiveness of subject-integrated school garden teaching.

Keywords: School garden, teaching, learning, subject integration, effectiveness

## **Introduction**

School gardens are not merely places where students grow vegetables – they constitute a learning environment in which nature, food and taste play a key role in the educational activities that take place there (Kangas et al. 2017; Wistoft 2013). In school gardens students can learn to interact with the outdoors and thereby develop understandings of nature (Bowker and Tearle 2007; Wistoft and Dyg 2017). Gardening can develop students' critical awareness of environmental problems (Ampuero et al. 2015). The conceptual world of students is expanded through school garden programmes when they learn to distinguish between vegetables in a more capable way (Richards 2010). As their curiosity increases, they express a desire to become familiar with new vegetables which they have not previously grown, harvested or tasted (Ratcliffe et al. 2011). School garden research demonstrates effectiveness in relation to students' competencies in the form of skills, knowledge, social competence, personal development and wellbeing (Kirby 2008; Nyberg 2014; Walter 2012). In other words, school garden teaching programmes have many positive effects – so why are they not more widespread?

One plausible explanation may be that all over the world there is increasing emphasis in schools and in school policy on academic performance in subjects like mathematics, languages and science (Berezowitz et al. 2015; Grek 2009; Moutsios 2010; Reynolds et al. 2014). For instance, one evaluation of Norwegian school gardens concludes that teachers and principals feel increasing pressure to ensure that their students perform well in national tests and international comparative studies. This can lead to more teachers maintaining traditional indoor classroom teaching, which they know and feel comfortable with, at the expense of school garden or other outdoor teaching – which are not viewed as sufficiently effective in ensuring that students meet learning objectives

(Jolly and Leisner 2012; Passy 2014). Additionally, learning environment research indicates that a majority of teachers prefer direct instruction, and therefore seldom use the kind of teaching generally seen in most school gardens (Roelofs, Visser and Terwel 2003). We find this to be paradoxical in the light of outdoor education research, which indicates that learning spaces outside the school in general are known to have positive effects on a wide range of aspects (Dillon et al. 2016; Peacock and Pratt 2011).

We also find it paradoxical in the light of existing research on the effectiveness of school garden teaching in relation to the academic learning outcomes of students. For instance, Williams and Dixon (2013) have carried out a systematic literature review of garden-based learning on academic outcomes in subjects like mathematics, languages and science in primary and lower-secondary schools. They analyse 152 research articles concerned with garden-based learning in schools published between 1990 and 2010, and assess 48 of these studies as valid, reliable and relevant in terms of their research aim. More than 80% of these articles document a positive effect, less than 5% document a negative effect, and around 15% document no effect at all. Blair (2009) has also carried out a review, a study of American research on garden-based learning, aiming to investigate what effect school gardens have on students' academic outcomes and teachers' views on school gardens as learning environments. Blair concludes that teaching in school gardens helps children to achieve better results academically and personally than children who do not have access to school gardens as an integrated part of their teaching.

Based on the research outlined above, we presuppose that school gardens can potentially enhance students' skills, knowledge, social competence, personal development and wellbeing, as well as their critical awareness of environmental problems. But in modern schools it is often essential that teaching activities also have a positive influence on the academic outcomes of students in subjects like mathematics, languages and science. School gardens do have this potential when subject-integrated teaching is carried out (Blair 2009; Williams and Dixon 2013; Williams et al. 2018). However, not all school garden programmes are effective in terms of achieving outcomes in core academic subjects (Pascoe and Wyatt-Smith 2013; Pigg, Waliczek and Zajicek 2006). Our study aimed to investigate the characteristics of school garden teaching in order to identify those that enhance the academic outcomes of students. Specifically, we were concerned with identifying the factors which ensure the effectiveness of school garden teaching with regard to the subject integration of mathematics, languages and science. We undertook this investigation by mapping and synthesising across studies.

## **Methodology – Integrative Literature Review**

This study is based on an “integrative literature review” (Souza, 2010; Torraco, 2005; Whittemore & Knafl, 2005). This is not a systematic review aimed at providing a total overview and quality assessment of all existing research within a field (Boland, Cherry and Dickson, 2014). However, it is still important to have a systematic approach when performing an integrative review. This methodology provides a comprehensive understanding of a complex phenomenon by synthesising the most prominent qualitative and quantitative research results related to the phenomenon (Cynthia 2005). In brief, the integrative literature review includes a clear description of the focus of the research, a well-defined literature search strategy, systematic evaluation of studies, and compilation of a transparent collation of findings (Souza, Silva and Carvalho 2010; Whittemore and Knafl, 2005). With this point of departure, we conducted literature searches using the software platform ProQuest in 22 research databases. In relation to developing search terms, we considered whether

we wanted the searches to aim at outdoor teaching in general or school gardens in particular. We discovered that a search term such as “outdoor education” resulted in an unmanageable number of publications, including many with little more than a tenuous link to our research focus. As a result, the review searches were limited to the search terms (“school\*” AND (“garden\*” OR “farm\*”).

The main focus of our study is subject integration, which we define as a link between school subjects and school gardens. Incorporating this focus has been a challenge, because the international research literature uses a variety of terms such to express this phenomenon, including interdisciplinary teaching, cross-curricular teaching and subject interrelation. Furthermore, we have discovered that school subjects can be linked with school gardens through a variety of approaches. Some emphasize the development of garden-integrated curricula and teaching plans. Others stress the combination of specific teaching methods and utilisation of their advantages in different settings. Another approach involves development of the learning environment of the garden so that it can incorporate school subjects to a greater extent. These are just a few of the approaches that emerged when studying this field, and we will explain them in greater detail below.

It has not been our intention to exclude specific approaches from the study. Instead, we have tried to identify the most prominent approaches in terms of linking school subjects with school gardens. By an explorative search process, we arrived at the following search terms: (“subject\*” OR “curricul\*” OR “course\*” OR “lesson\*”) AND (“integra\*” OR “cross\*” OR “interdisciplina\*” OR “multi\*”) AND (“learning\*” OR “learning environ\*” OR “teaching\*” OR “didactic\*” OR “academic\*”). Given the particular focus on mathematics, languages and science, we added (“mathematics\*” OR “language\*” OR “science\*” OR “physics\*” OR “chemis\*” OR “biolog\*”). Most school garden programmes are aimed at primary and lower-secondary schools. As a consequence we limited the searches by using the search terms (“elementary” OR “primary” OR “middle” OR “junior high OR lower-secondary”) because they sufficiently covered the international terms employed to refer to the school cohorts that use school gardens when subject integration is relevant. Most integration of school gardens addressed all children without distinguishing between ethnicity, age and gender, so the searches were not limited in these respects. We carried out a number of explorative searches to arrive at the final search string, resulting in 88 peer-reviewed research results in the ProQuest search. In this initial selection process, we screened abstracts of the 88 results according to the following inclusion criteria:

- The studies must include a link between school subjects and school gardens with a focus on one of the following: students’ learning outcomes, conditions for learning, effectiveness, or teachers’ links between subjects and school garden. In short, garden, subject, teaching and learning must be included.
- The studies must relate to languages, science or mathematics.
- The studies must be peer reviewed and published.
- Studies from before 2000 are excluded, with the intention of only including recent research.
- The studies must be directly based on, or review studies based on, empirical data.
- The studies must describe methods transparently, making it clear how the research was carried out and how the results were obtained.

We followed up the initial selection by screening abstracts of all the 88 articles identified. We systematically excluded those that did not comply with the inclusion criteria. When there was doubt, the entire article was read and assessed. In a further selection process, the reference list of all the articles that related to our focus was screened to find other relevant studies. These two selection

processes resulted in identification of 15 studies, which we assessed as most prominent and of sufficient quality.

## **Limitations**

It could be argued that the number of research articles included in this study is insufficient. This would certainly be the case for a systematic review whose intention was to reveal the entire landscape of research carried out within a specific research field such as the influence of school gardens on academic achievement. However, as we explained earlier, such systematic reviews have already been carried out (Blair 2009; Williams and Dixon 2013). Additionally, the epistemological interest of our study is more narrow, and the shortage of research makes a systematic review inappropriate in terms of answering the research question. So the integrative review is more appropriate, even though it has limitations.

Another limitation that we stress is that this review does not provide any recommendations about the best possible teaching practice in relation to integrating academic subjects with school garden teaching. This will always depend on the teaching context, so it will be based on the teacher's didactic reflections and professional judgement with regard to the specific school garden teaching in question. Nevertheless, even though subject integration with school garden teaching can be achieved in a multitude of ways, the existing research still identifies certain general factors that can ensure the effectiveness of school garden teaching in integrating mathematics, languages and science. In this article we have mapped and synthesised such factors into major themes that may be of relevance to school garden programmes and future research. Once again, it is important to be aware that these factors need didactic reflection, interpretation and modification if they are to be transferred and implemented in specific school garden teaching.

It is our assessment that the quality of some of the research carried out in the mapped studies could be challenged. One example is the study by Smith and Motsenbocker (2005), which reports the results of an intervention study consisting of a school garden programme that integrates the science curriculum. It concludes that the intervention has a positive effect on the students' performance in science. This conclusion is confirmed by other research (Williams et al. 2018). However, it is our judgment that several methodological problems exist in this study, such as low Cronbach alpha and P-values. Yet we included this particular study because it is still one of the best available. In other words, there is a shortage of solid experimental studies in the field. We regard the other studies included here as predominantly good research practice. However, the lack of research stringency is a general problem (the failure to describe research methods, sampling techniques, validity and reliability). This is also partly the explanation for why we excluded most of the 88 search results. The existing research still lacks more solid empirical evidence, as indicated by the relatively small number of studies included here. Consequently, we recommend that more systematic and stringent research should be carried out with regard to the factors that enhance effective links between subject teaching and school gardens.

## **Results and Discussion**

### **The mapped studies**

Most of the mapped studies selected, 13 of the 15, were American; while the remaining two were based on British and Australian research. The reason for this may be that school gardens are

relatively widespread in the USA, and for this reason more time, opportunity and incentive may have been accessible to integrate subjects and school gardens. The reader should of course be aware of this limited geographical spread. However, we do not interpret this as a bias, but rather as a noteworthy indication that researchers in the USA have made a great deal of progress with regard to researching school garden teaching and subject integration.

Students from grades one to nine (6-15-year-olds) were included in the mapped studies. Several of the studies investigated school gardens at more than one grade level, with the most common grade levels investigated being from third to sixth grade. Consequently, our integrated literature review is most relevant in relation to these intermediate grades. The specific breakdown in relation to grade levels is provided in figure 1.

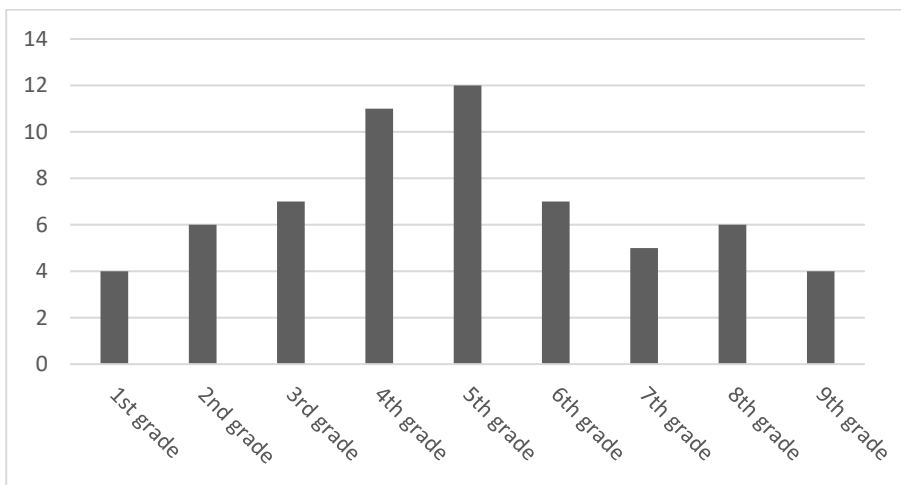


Fig. 1 Grade levels included in the mapped studies

The oldest study that satisfied our inclusion criteria was from 2005; the most recent was from 2015. The majority (11 studies) have been published within the last ten years. However some of the studies draw upon data from before 2005, including Williams and Dixon (2013), which is a review of studies in the period 1990-2010.

We also investigated the type of research that was used in the mapped studies – the research design and methods on which the studies were based. These included literature reviews, experimental studies based on quantitative methods, qualitative studies utilising interviews and observation, surveys generating quantitative data from closed questions combined with open ended questions producing qualitative data.

The three literature reviews were all based on systematic mappings of existing empirical research related to school garden teaching. They all intended to summarise what is known from existing research about the field and assess the quality of this research in terms of validity and reliability. The five experimental studies were all based on quantitative research methods and designed to ensure that the student’s academic position in subjects is measured before and after an intervention in order to measure educational effectiveness in terms of academic achievement. For all five studies, the intervention involved a form of school garden teaching used to teach students mathematics, science and language. A control group of students who received “ordinary” teaching was used to collect comparable data, after which research results were discussed through statistical

comparisons. The three qualitative studies focused on exemplary ways in which subject integration can be practised in school gardens. An in-depth and nuanced understanding of the potentials and challenges associated with specific examples of school garden teaching was investigated. The one study that only utilised a survey examined the use of school gardens in practice, as well as studying attitudes towards the use of gardens in schools and perceptions of the barriers associated with using school gardens for subject-integrated teaching. It employed a quantitative method in which an electronic questionnaire was distributed. In the three mixed-method studies, a combination of quantitative and qualitative methods was used involving questionnaires, tests, interviews and observations. These studies tried to combine the benefits of the various types of research we have defined above.

As can be seen, the studies include a broad range of methods, which in our judgement helps to ensure a sufficiently varied empirical foundation and allows us to extract both knowledge of a general nature and more context-specific knowledge, both of which have strengths and weaknesses. The advantage of including both types of knowledge is that they complement each other, thereby increasing the reliability of our literature review. The fact that many of the different studies came to similar results and conclusions despite the use of different methodological approaches is particularly significant. On the other hand, some of the results are divergent – something which can be studied through the in-depth analysis of their methodological approach. We elaborate on this point below.

### **Factors influencing successful subject integration in school garden teaching**

To derive the factors that influence successful subject integration in school garden teaching, we further analysed the 15 mapped studies by conducting content analyses. Methodically, we have been inspired by Hsiu-Fang Hsieh and Sarah E. Shannon and their presentation of directed content analysis (Hsieh & Shannon, 2005). Here, the analytical focus is on the characteristics of language as communication with the purpose of deriving the contextual meaning of the text. Our approach has been to make an exploratory reading of the 15 articles, and simultaneously code themes when a study stressed factors related to the integration of school subjects in school gardens and vice versa. In other words, we coded all text in the articles where it was stressed what was important in regards to ensuring the effectiveness of subject integrated school garden teaching. This included factors having positive and negative influence. By extracting the results of this analytical process in of our integrative literature review 12 themes emerged, each of which was associated with particular studies (see Table 1).



Table 1: List of studies and their themes

<b>Themes</b>	<b>Studies</b>
An acceptable level of academic outcome is perceived as non-compatible with school gardens by some teachers.	(Berezowitz et al. 2015), (Blair 2009), (Hazzard et al. 2011), (Passy 2014)
Collaboration between school staff as well as collaboration with people outside the school.	(Blair 2009), (Graham et al. 2005), (Hazzard et al. 2011)
Combination of indoor and outdoor teaching.	(Luna et al. 2015), (Pascoe and Wyatt-Smith 2013), (Selmer et al. 2014), (Smith and Motsenbocker 2005), (Winters, Ring and Burriss 2010)
Experiential learning as an essential teaching method.	(Berezowitz et al. 2015), (Blair 2009), (Fisher-Maltese 2013), (Klemmer, Waliczek and Zajicek 2005), (Pigg, Waliczek and Zajicek 2006), (Selmer et al. 2014), (Williams and Dixon 2013)
Formal and informal teaching.	(Fisher-Maltese 2013), (Selmer et al. 2014)
Hands-on learning as an essential teaching method.	(Berezowitz et al. 2015), (Blair 2009), (Fisher-Maltese 2013), (Klemmer, Waliczek and Zajicek 2005), (Luna et al. 2015), Pigg, Waliczek and Zajicek 2006), (Selmer et al. 2014), (Smith and Motsenbocker 2005), (Williams and Dixon 2013)
Keeping the garden aesthetically attractive was the key to motivating students and teachers.	(Hazzard et al. 2011)
Linking the school garden to the academic curriculum, and/or lack of garden curriculum.	(Graham et al. 2005), (Hazzard et al. 2011), (Klemmer, Waliczek and Zajicek 2005), (Pascoe and Wyatt-Smith 2013), (Pigg, Waliczek and Zajicek 2006), (Williams and Dixon 2013)
Problem solving and project-based learning as a teaching method.	(Kirby 2008), (Selmer et al. 2014)
Despite increased learner engagement, school gardens alone do not guarantee effective student learning.	(Pascoe and Wyatt-Smith 2013), (Pigg, Waliczek and Zajicek 2006), (Williams and Dixon 2013)
Student participation/student involvement as an essential teaching method.	(Fisher-Maltese 2013), (Kirby 2008)

Teacher's lack of personal interest, capability, knowledge, education or time.

(Blair 2009), (Graham et al. 2005), (Hazzard et al. 2011), (Passy 2014)

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We will argue that some of the themes presented in table 1 can be interpreted as interlinked. So in the next sections we will address all 12 themes by presenting our synthesis, in the form of four broader threads that connect the various interlinked themes. These threads are: 1) garden curriculum and specific teaching plans; 2) essential teaching methods; 3) collaboration as a necessity for successful subject integration; and 4) the integration of indoor classroom teaching in the school garden – and vice versa. In combination with our synthesis of themes, we will discuss these by incorporating other research within the threads.

#### *Thread 1. Garden curriculum and teaching plans*

Some schools find it difficult to gain support from teachers who have no experience of gardens as a teaching medium, or teachers who cannot see the advantages of moving their teaching outdoors (Hazzard et al. 2011). This is despite the fact that research indicates that outdoor learning environments and learning spaces outside the school in general are known to have positive effects on a wide range of aspects (McLeod and Craig 2007; Neill and Richards 1998; Peacock and Pratt 2011). They can increase physical activity, children's imagination and creative development (Davies 2013; Nedovic and Morrissey 2013). They can support students who underachieve in the indoor classroom (Maynard, Waters and Clement 2013). And outdoor education can offer alternative teaching to positively complement indoor teaching (Davies 2013; Passy 2014).

The studies mapped in this article indicate that one essential way of helping subject teachers to link their teaching to gardens is to develop specific teaching plans and a school garden curriculum (Williams and Brown 2012), i.e. concrete descriptions of what the students can be expected to learn in school gardens. Developing specific teaching plans means providing clear learning objectives all the way down to single lesson level, as well as descriptions of teaching methods and hands-on outdoor activities. Furthermore, it is vital to show teachers how they can evaluate their teaching (Yan and Kember 2003). The degree of detail in curricula and teaching plans may vary a great deal, and there may be vast differences in the ways in which teachers prefer to devise them (Graham et al. 2005; Hazzard et al. 2011; Klemmer, Waliczek and Zajicek 2005; Williams and Dixon 2013). Consequently, it is also essential that garden curricula are developed in a way that facilitates adaption to the teaching context. The school garden itself, despite increased learner engagement, does not automatically guarantee effective student learning. It is vital to link school gardens with the curriculum and literacy in order to ensure the effectiveness of the teaching in terms of the academic outcomes of the students (Pascoe and Watt-Smith 2013; Williams and Dixon 2013).

#### *Thread 2. Essential teaching methods*

According to several studies, school garden teaching is characterised by its high degree of hands-on experience, experiential learning processes and student participation. We view these as essential teaching methods, and they are consistently emphasised as an essential difference between traditional indoor classroom teaching and outdoor school garden teaching (McCarty 2010; Fisher-Maltese 2013; Luna et al. 2015; Pigg, Waliczek and Zajicek 2006; Selmer et al. 2014; Williams and Dixon 2013; Winters, Ring and Burriss 2010; Wood 2010). The definition of the term "traditional indoor classroom teaching" is often vague in the cited studies; and it is our interpretation that scholars often regard the meaning of this term as a matter of simple common sense. In the few

explicit definitions that exist, traditional indoor classroom teaching primarily involves the students sitting at desks listening to the teacher or following instructions. Several of the studies acknowledge that not all indoor teaching is like this, but nonetheless maintain that such teaching practices are very dominant – particularly in subjects like mathematics, languages and science.

One common denominator across several of the studies is that they refer to the term ‘experiential learning’, a teaching method in which the students learn through investigation (Gray and Martin 2012; Ord and Leather 2011; Wurdinger and Paxton 2003). The approach to this teaching method may be more or less teacher directed in the form of exact instructions regarding how the students are expected to investigate, and the teacher may even leave (almost) everything up to the students, only defining the overall framework for the teaching. The approach which is recommended most often involves the teacher reflecting on how to create a balance between these positions (Blair 2009). We argue that achieving a balance in this context does not necessarily mean that both positions are equally represented. Instead, it is essential that the teacher is aware of the different positions, reflecting on what will make most sense in their teaching practice and planning the teaching accordingly. The goal is that a learning environment should be established in which the teaching approach ensures that the subject in question and the garden are linked.

Most of the studies referring to experiential learning processes also point out the importance of the students getting something in their hands – the essence of the ‘hands-on’ concept (Silverman and Corneau 2017). A hands-on approach can be achieved by pricking out seedlings, letting the students get soil under their nails, experiencing the tactile difference between different seeds and plants, and doing the physical work related to maintaining the school garden, for instance. This can make the teaching less abstract and more meaningful. At the same time, this approach involves a form of teaching that activates more bodily senses, leading to the potential enhancement of learning processes (Bowker and Tearle 2007). Research has also demonstrated that this teaching method has the potential to include students who are not academically strong, because the learning is not dependent on reading skills (Block et al. 2012).

The above-mentioned teaching methods can be viewed as a specific form of problem solving and project-based learning (Kirby 2008; Selmer et al. 2014), something which has also been dealt with in research into learning in general (Dochy et al. 2005; Gräsel, Fischer and Mandl 2000; Hugerat 2016; Lindblom, Pihlajamäki and Kotkas 2003; Wijnen et al. 2017). Problem solving and project-based learning are known to engage the students, enhance their level of participation and strengthen their feeling of relatedness. Nevertheless, in light of the earlier points in this article, we believe that it is essential to maintain a link between the teaching methods and the curriculum. If there is no link between subjects such as mathematics, science and languages and the problem-based learning which is facilitated in the school garden, then it is also unlikely that school garden teaching alone will enhance the academic learning outcome.

### *Thread 3. Collaboration as a necessity for successful subject integration*

Several of the studies that we have mapped emphasise that collaboration between school staff is vital with a view to ensuring successful subject integration (Graham et al. 2005; Hazzard et al. 2011; Selmer et al. 2016). Success depends on each subject teacher’s knowledge being combined with knowledge about how the garden is used as an outdoor teaching medium. Furthermore, the garden needs to be continuously maintained in order to remain an attractive place to teach. The school garden should be fertile, inviting, attractive and aesthetically pleasing (Hazzard et al. 2011; Kangas et al. 2017). However, continuous care and maintenance are required to ensure that a school

garden remains a place in which students and teachers feel comfortable, something which is fundamental to facilitate teaching and learning. The studies included here indicate that these essential tasks are difficult to perform at the individual teacher level, making collaboration between teachers across academic divisions fundamental in order to integrate subjects in school garden teaching. Some successful school garden programmes collaborate with gardeners or volunteer workers in order to maintain their appearance. Basically, anyone interested in maintaining the school garden is a possible resource.

#### *Thread 4. Integrating indoor classroom teaching with the school garden and vice versa*

Research into learning environments addressing outdoor education, out-of-school learning or place-based learning often draws a distinction between the indoor classroom and the specific learning environment of interest (Peacock and Pratt 2011; Zandvliet 2012). Several of the studies mapped here also draw this distinction, with the school garden and indoor classroom being presented as distinct entities (Luna et al. 2015; Pascoe and Wyatt-Smith 2013; Rye et al. 2012; Selmer et al. 2014; Smith and Motsenbocker 2005; Winters, Ring and Burriss 2010). We believe that this distinction entails the risk of presenting the two learning environments as contrasting or incompatible, which is problematic because this is not the case. Some teaching is better facilitated in the indoor classroom, while other teaching is more suited for the school garden (Winters, Ring and Burriss 2010). Teaching should therefore not be planned according to ‘either ... or’ but rather according to ‘both ... and’.

Furthermore, we argue that it may be appropriate to establish a link between the two distinct physical learning environments instead of viewing them as contrasting or incompatible. In this respect, we would like to refer to Williams and Brown (2012), who argue that the dominant way of organising teaching in schools springs from an outdated mindset dating back to the period of industrialisation at the beginning of the 20th century. This mindset includes teaching divided into subjects in the same way that factory labour is divided into specific functions. Both phenomena are structured by timetables which stipulate what can be included and when these are supposed to take place, with a bell marking changes in both labour functions and school subjects. The problem, according to Williams and Brown (2012), is that even though this may be a practical way of structuring and managing a school, it is not necessarily a good way of facilitating learning processes. Learning does not begin and end when the bell sounds, but occurs most advantageously when students are deeply involved in the tasks they are working on within the teaching. In this sense, it may also be problematic to adopt a school structure in which subjects continuously replace one another, thereby disrupting learning processes (Williams and Brown 2012). We argue that in the light of the literature mapped in this article, the subject-integrated school garden can be viewed as a teaching form that addresses this issue. Instead of changing from one subject to the next without effective links, a school garden project can function as a focal point that ties several school subjects together around a teaching activity that allows academic immersion.

As mentioned, another challenge in this context is that teachers may have very different views on the potential of school gardens regarding subject-integrated teaching (Passy 2014). Teachers who are not motivated by outdoor life and gardening may be particularly reluctant to support the idea of school garden teaching. And if they also fail to recognise what the garden can contribute to the students’ learning outcomes in their subject, it is unlikely that they will choose to engage. An evaluation of Norwegian school gardens by Jolly and Leisner concludes that teachers and principals feel an increasing pressure in terms of students performing well in national tests and international comparative studies like PISA, TIMSS and PIRLS. This can lead to more teachers maintaining

traditional indoor classroom teaching, which often involves the students sitting down and receiving direct instruction. This is because teachers are more used to such a teaching method, and because they feel more comfortable when using it. The challenge is that this approach may be at the expense of school gardens, which are not viewed as sufficiently effective in ensuring that the students meet learning objectives and thus risk being discarded (Jolly and Leisner 2012). We find this risk paradoxical in the light of this literature review, given that it has been documented that school gardens in general have the potential to strengthen students' performance levels in mathematics, languages and science – subjects that are included in national tests and international educational studies.

## **Conclusion**

School gardens can afford learning environments which integrate subject teaching that allows students in general to acquire knowledge, skills and competences in mathematics, languages and science. At the same time, it is important to emphasise that not all school garden programmes show positive results regarding students' academic outcomes. Some studies indicate that school gardens generate the same learning outcomes as traditional classroom teaching – or even a lower level. In other words, school gardens do not always have an unequivocally positive effect on students' academic learning, and subject integration is not always a success. The effectiveness of subject integration relies on several factors related to the school garden teaching in question, which we have synthesised in four threads: 1) garden curriculum and specific teaching plans; 2) essential teaching methods; 3) collaboration as a necessity for successful subject integration; and 4) the integration of indoor classroom teaching in the school garden – and vice versa.

The research results that constitute the above four threads indicate that it is vital to develop a school garden curriculum which describes how subject integration should take place in the school garden through teaching practice. Such a curriculum should include an annual plan for the continuous school garden teaching activities and related academic learning topics, along with descriptions of concrete teaching courses (lasting a couple of months, for instance), with overarching learning objectives for the integrated subjects. Furthermore, lesson plans should describe in detail the learning objectives for each lesson, how teaching activities are to be carried out in relation to these objectives, and how the students' outcomes are to be evaluated. The teaching should also be planned so that the students work in an experimental way that activates their senses. Involving several staff groups, subject teachers and volunteers in the school garden is central, drawing on different competences to facilitate the optimal conditions for the students' learning. Finally, it is important that the school garden remains aesthetically pleasing, offering a place in which students enjoy learning, and where teachers enjoy teaching. The integrated school garden can be a medium to support students' subject-specific learning. Sometimes this is best facilitated in an indoor classroom, while the school garden may be preferable on other occasions; but there is significant learning potential to be gained by providing a link in which knowledge and experience acquired in one setting can be transferred to and used in the other.

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