Playponics

PEDAGOGY REVIEW REPORT

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Contents:

Executive Summary

This Playponics review report provides an overview of the potential of integrating Playponics into the Indian national curriculum, specifically within Science, Technology, Engineering, Maths and Environmental Education, although other subject areas will be explored as well. In order to achieve this, an understanding of broader issues affecting children's education within India will be briefly examined. These issues are found in three main interconnected areas: Poverty, Health and Education, with the overall focus being on education and the application of Playponics in this area.

Challenges faced within the Indian education system are highlighted, along with the impact of poverty and health upon children in their pursuit of education, with the potential benefits of the Playponics project coming towards the end of the report. How the Playponics system could be implemented as an active resource within the five key principles of the National Curriculum Framework (2005) through the transition period to full application of the new National Education Policy (2020) with an exemplar collated framework evidencing the relationship between Playponics outcomes and potential synthesis with the curriculum will also be dealt with in brief.

Lastly an overview of the current and anticipated changes to the evolving and innovative approaches that need to be considered with the implementation of the new National Educational Policy (NEP, 2020) are taken into account.

Objectives

The following objects have been examined within the report:

- The child experience in India and education - the challenges faced **(see section 1&2**).
- Playponics pedagogic intent and reality – with potential framework outline for Playponics to scaffold STEM subjects **(see section 3)**
- Recommendations of considerations to enable Playponics system to enhance the curriculum supporting the New National Education Policy (2021) **(see section 4)**

Project

Playponics is an innovative concept in sustainable education, defined as the integration of sustainable education blended across Science, technology, Engineering, and Mathematics (STEM), melding hydroponics technology into children's outdoor play equipment. This resource will utilise children's natural engagement with play such as swings, see-saw, barrel run, etc., to harness their kinetic energy. This harnessed energy is channelled through the equipment to move water and nutrients through the larger hydroponics system. This innovative design will facilitate children's play while also harnessing this play into supporting the growth of plants that can be used as a source of complementary food for the school or community, while also acting as a kinaesthetic educational resource to engage and enhance learning within schools and local communities.

Methodology

A qualitative summary providing evidence on topics related to Playponics and the child experience of education within India to create a literature review. This review leads to recommendations for best practise in the use of Playponics as an educational tool to support STEM subjects within Indian schools along with insight into appropriate pedagogical application.

Section 1: The child experience in India and education: Context

Indian Child Demographic Overview: A 2018 report by the Ministry of Statistics and Programme Implementation states that India is home to the largest child population in the world (Lochan et al, 2018). According to the 2011 census, children in India aged 0-14 years constitute 30.76% of the total population, with 48% of this group (0-14 years) being female. 74% of the children aged 0-6 years live in rural areas whereas the rural population constitute 69% of the total population of India.

Poverty Statistics: Improvements in poverty levels within India have occurred, with the United Nations Development Programme (UNDP) suggesting "India lifted 271 million people out of poverty in a 10-year time period from 2005/06 to 2015/16"(UNDP, 2018). However, poverty is still endemic within India: the United Nations Millennium Goals (MDG) programme reports approximately 88 million people out of 1.2 billion Indians, roughly equal to 6.7% of India's population, living below the poverty line of $1.25 in 2018–19 (World Bank, 2010; The Hindu, 2016; Kharas and Chandy, 2014).

Health Issues and Poverty: Lochan et al (2018) reports an all-India level of children under the age of 5 years as being stunted (height too short for their age) at 38%. This suggests issues with nutrition throughout India. The current figures for stunted growth have improved from 48% in 2005-06. Stunted growth is higher among children in rural areas (41%) than that of urban areas (31%). Across India, both rural and urban, 21% of children under age five years are wasted (too thin for their height). As the stunted growth and 'wasted' appearance of children is prevalent, it suggests that nutrition is one key component to be explored in more detail for the children of India. Lochan et al (2018) notes that across India, 28% of children had mild anaemia while 29% had moderate anaemia, and 2% had severe anaemia in 2015-16. The National Health Service of the United Kingdom (2018) defines Iron deficiency anaemia as being "caused by lack of iron, often because of blood loss or pregnancy. [Iron deficiency anaemia is] treated with iron tablets prescribed by a doctor and by eating iron-rich foods". Once the patient is tested and assessed by a health care practitioner, appropriate treatment can be prescribed; this could include medication such as Iron tablets. If diet is determined to be partly causing the iron deficient anaemia, then the patient could adapt their diet by increasing dark-green leafy vegetables, cereals and bread with extra iron in them (fortified), meat and or pulses (beans, peas and lentils).

However, access to a health care practitioner, assessment, and treatment with changes to diet such as an increase in leafy green vegetables would all require available funding and access to current available healthcare. This could mean an additional journey requiring transportation, which would further increase the financial cost of accessing healthcare, which is problematic for this segment of India's population. The Organisation For Economic Co-Operation And Development (OECD) and the World Health Organisation (WHO) (2003) confirms the relationship between poverty and health stating:

> "The poor suffer worse health and die younger. They have higher than average child and maternal mortality, higher levels of disease, and more limited access to health care and social protection. And gender inequality disadvantages further the health of poor women and girls. For poor people especially, health is also a crucially important economic asset. Their livelihoods depend on it. When poor people become ill or injured, the entire household can become trapped in a downward spiral of lost income and high healthcare costs. Investment in health is increasingly recognised as an important means of economic development and a prerequisite for developing countries – and particularly for poor people within them – to break out of the cycle of poverty. Good health contributes to development in a number of ways: it increases labour productivity, educational attainment and investment, and it facilitates the demographic transition. Therefore, the poor within India are suffering ill health and poverty intertwined, affecting health, growth, education and a reduced life span."

Education: The British Council (2019) states "The school education system in India is the largest in the world, catering to over 260 million young people each year". The education at the national and state level is jointly managed with recognition of the many challenges faced by the historic education system. Many initiatives have been undertaken to improve access to quality schooling – particularly for those who are economically or socially disadvantaged. This includes the new 'National Education Policy' (NEP) released in July 2020 to support the whole education system, including national and private schools. Of note, there is robust competition from the private education schooling sector. The current national curriculum policy is the National Curriculum Framework 2005, which is due to be updated by the new 'National Curriculum Framework for School Education (NCFSE). This is set for release 2020-21 (this has not been released at the writing of this report). This updated curriculum will support the innovative changes within the NEP 2020.

Regardless of changes to come from the new National Educational policy, Lochan et al (2018) reports a current Indian Literacy rate among children (7-18 years) standing at 88.3% with the gender gap observed for this age group at 3% in 2011. In 2015-16 enrolment data reveals that the Gross Enrolment Ratio (GER) at Primary level is 99.2%, whereas at Upper Primary level is 92.8%; Secondary level it is 80.0% with Senior Secondary levels being 56.2%. Therefore, by the time children reach secondary level, almost 43% of children are no longer enrolling or attending education.

Multiple sources, such as Gindra (2020), Krishna (2017) and Banerji (2020) examine the educational issues within India. All of these highlight the importance of education within society as a key aspect of social foundation, and all three note the primary challenges faced within Indian education today, with these being:

- Lack of capital
- Mass illiteracy
- Problems of primary education
- General education orientated
- Neglect of Indian Languages
- Wastage of resources
- Expensive higher education
- The problem of Brain Drain to more developed economies, such as the USA
- Impact of the Pandemic on Primary Education

Lack of Capital: The absence of adequate financial assets is the fundamental issue that needs addressing in order to improve educational instruction and, therefore, the learning experience of the student. An example of this is the diminishing support for training in Multi-Year Designs. Gindra (2020) notes that this asset issue is due to inadequate finances, framework and resources such as science equipment, libraries, etc.. Krishna (2017) reports that ultimately a lack of finance and resource is directly negatively affecting educational outcomes. School infrastructure is in a poor state and many school teachers are not properly qualified, with 31% of them not having a degree. Furthermore, 40% of schools are without electricity and there are schools where during exam time, the invigilators ignore the students, giving them full freedom to cheat, and at times the teachers themselves abet the act of cheating. Additionally, there are instances where the children are asked to sweep the floors, serve meals to the teachers, and children as young as six are repeatedly beaten with rulers. Consequently, the state of learning is very poor. This is highlighted by the Annual Survey of Education Report (ASER), which found that a substantial number of government schools have 14-year-old students six years behind what would be expected of them on average. These circumstances create a predicament for socio-economically deprived groups, who cannot afford a private school to educate their child. Krishna (2017) furthers that the ASER states that children's literacy has not risen commensurately. For example, 14-year-old children are often unable to read texts which a child of eight could be expected to read. As in many schools (Indian or otherwise), the teachers are completely ignorant of the subject being taught and the needs of the students, with learning revolving around the children copying down lessons from blackboards (Rote learning model). Statistics also show that only 9.5% of government schools are Rights of The Education Act (2009) compliant. In other words, only 9.5% of the schools are providing free education to children between the ages of 6 and 14.

Mass Illiteracy: Although there are governmental protected mandates and financial planning, Gindra (2020) states that 100% educational attainment is not yet feasible as approximately 35% of individuals stay uneducated. In India, the quantity of illiterate individuals is very nearly 33% of the aggregate (Gindra, 2020). Banerji (2020) further explains that schools are not producing the expected results. New data shows that even after five years of school, only about half of India's children have attained the level in reading or arithmetic expected after 2 or 3 years. The root causes of this shortfall in learning are embedded in families as well as schools. Banerji (2020) suggests that approximately 50% of rural school-going children in India have mothers with no or very little education, providing little active support for learning at home. Parents with a low educational level may not be able to identify when a child is not progressing, and lack confidence to communicate with teachers about this. Parents often assume that schooling will automatically lead to learning, without realising that extra parental effort may be needed. The rigid structure of India's schools allow children to fall behind – teachers are expected to stick to the curricula and textbooks for each grade, and cannot spare much time to help children who are below that level. Banerji (2020) furthers knowledge on this issue of poor attainment by reporting that until recently there was little assessment of students in early grades to identify those who had fallen behind. Nor were there organised or systematic remedial efforts within the school system (government or private) to help them. As a result, basic foundational learning (reading and arithmetic) is generally low, even after the completion of the primary school cycle. More worryingly, learning trajectories are flat – implying that if a child does not learn basic, foundational skills early, they are unlikely to acquire them in later school years. India's Right to Education Act guarantees eight years of schooling to each child. However, at the end of these eight years, the foundation on which future skills, further education, or indeed lives are built, could be considered weak (Banerji,2020).

Problems of Primary Education: Gindra (2020) suggests that Indian primary education is faced with multiple issues ranging from a lack of environmental structure, with basics like clean drinking water, toilets, electricity, furniture, study materials, etc., missing or limited. There are also known issues with limited qualified staff (and some schools with no qualified staff) leaving the quality of primary education to be questionable. This again impacts on retention and achievement of students, as well as wider literacy rates, and raises questions around teacher training and education needed to improve standards. The Saakshar Organisation (2017) reported that in 2017 the student-teacher ratio in India stands at 24:1 across all levels of schooling. This is a positive statistic in light of the Right to Education Act (RTE) stipulation of a ratio of 30:1. The RTE act has called for sufficient infrastructure, but less than 5% of schools have all of the 9 facilities mentioned in the act. Over 30% schools had no toilets, with over 60% of schools having no playgrounds. In the past few years, this primary education scheme has shown a high Gross Enrolment Ratio of 93–95% in some Indian states. However, the Saakshar Organisation (2017) highlights some of the reasons cited for the poor quality of education in schools include the absence of around 25% of teachers every day across India. Also, as per some online reports, the pupil to teacher ratio, specifically within the public school system for primary education, is 35: 1. The Saakshar Organization (2017) states a study of 188 government-run primary schools which found that 59% of the schools had no drinking water, and 89 percent had no toilets. The District Information System for Education (DISE) data shows that only 6 out 10 schools in the country have access to electricity. Bihar State is the worst offender with only 10 % of its schools having access to electricity. This a major issue for students as without electricity, schools cannot easily be cooled in the hot Indian summer, meaning that manageable environmental conditions can have a direct negative effect on student performance. As mentioned earlier, the quality of teachers is also important for student learning outcomes, but the DISE data shows that only 69 % of all school teachers in the country have a graduate degree, or more.

General Education Orientated: The education system has been predominantly focused on general education, with little choice in specialised subjects for students, until recent changes to the (new) National Education Policy (2020). This has led to a general feeling of hinderance in advancement of specialized and professional instruction, leaving specialist instruction as ineffective. Gindra (2020) notes that the number of educated jobless people is expanding daily, causing concern at state and national governmental level. However, with the new National Education Policy (2020) there is some government acknowledgement that compulsory Environmental Education, including sustainability via an infused approach, is needed. As such, STEM subjects will be given greater priority and resource within the education curriculum going forward (GEEP, 2010; and New Education Policy 2020).

Neglect of Indian Languages: There is a propensity to teach using English as the language of choice with an expectation that all students have the same level of English language understanding and ability. This occurs in many subjects, particularly science, often leaving some students behind in comprehension of scientific understanding due to language barriers. Standard distributions are not accessible in native Indian dialects and languages (Gindra, 2020).

Wastage of Resources: Gindra (2020) argues that the drop-out rate from general education has wide and varied impacts, which includes the wastage of financial and human resources. Lochan et al (2018) reports the number of children aged of 5-14 years who were in some form of employment instead of education constituted 4%, equalling 4.8 million children. Gulanker (2020) furthered this suggesting one out of every eight students enrolled in a school or college tends to drop out midway without completing their education. Furthermore, over 62% of all dropouts happen at the school

level, which a survey by the National Statistical Office (NSO) of the government of India has revealed.

Gulanker (2020) stated that overall, 12.6% of students drop out of studies in India, according to the NSO survey. More than one-third of the dropouts happen at the secondary and upper primary levels of education. While 19.8% of students discontinued education at the secondary level; about 17.5% of students dropped out at the upper primary level, the survey said. At the higher secondary level, the dropout rate is 9.6%. The survey defined a dropout as an "ever-enrolled person" who does not complete the last level of education for which he/she has enrolled and is currently not attending any educational institution. Gulanker (2020) suggests that the possibility of a person dropping out of academics declines as he/she attains higher levels of education or after he/she starts attending college. The dropout rate from education is lowest after the post-graduation level of education.

The NSO survey cited by Gulanker (2020) claimed both males (boys) and females (girls) tend to drop out at the secondary level the most. About 20.4% of boys, and 19.2% of girls stopped their education at secondary level. The dropout rate declines for both genders as they attain higher levels of education, as noted above. More than 40% of girls drop out because of marriage, or engagement in domestic (household) work. This breaks down as 13.2% of girls citing marriage, with 30.2% stating domestic work as the reason for discontinuing education. Most boys leave education to engage in economic activities to support their families, with this figure standing at around 36.9%. Financial constraint or non-affordability of education is still one of the major reasons for discontinuation of education in India (Gulanker, 2020).

Expensive Higher Education: The cost of Higher education (HE) such as college is expensive in its own right. In addition to the cost of college and HE is the common practise of the use of specialised instruction such as private tutors and educational mentors (Gindra, 2020) in supporting an individual's education and guiding career choices, which adds to the total cost of education. This makes the cost of education exorbitant and often beyond the range of an average salary expenditure. This means that children and young people of lower socio-economic standing often have to withdraw or drop out from secondary school to engage with employment, and contribute to the family finances themselves.

The Problem of Brain Drain: Limited economic and educational opportunity in India, and the promise of better financial prospects and educational attainment elsewhere, has led Indian nationals to seek improvements in their education and career in other nations, such as the United States of America, or European countries such as the United Kingdom. This migration of talent is often termed as a 'brain drain', which leaves India with a reduction in its educated and skilled talent-pool. Gindra (2020) muses that the individuals leaving could be better "utilized in our nation for the betterment of education as well as [the] overall development of the country".

The identified challenges within the Indian education system have come under further pressure due to the world wide pandemic of COVID-19. This has further highlighted the inequalities and difficulties faced by Indian students in accessing learning during lockdown periods, and will be touched on below.

Impact of the Pandemic on Primary Education

Drishti (2020) reports several additional issues highlighted following the pandemic in response to efforts to continue education during the Covid-19 pandemic. These include:

Connectivity and Resources issues: Many students from rural villages in addition to those from economically deprived backgrounds, are facing a serious issue in keeping up with online education due to a lack of technical resource such as computers, smart devices and general technical know-how within affected schools and communities. Only a handful of private schools could effectively adopt online teaching methods. As such, their low-income private and government school counterparts, on the other hand, have completely shut down due to not having access to e-learning solutions. The affected students, in addition to the missed opportunities for learning, no longer have access to healthy meals during this time and are subject to economic and social stress.

The pandemic has also significantly disrupted the HE sector as well, which is a critical determinant of a country's economic future.

Unpreparedness towards Digital Learning: Drishti (2020) notes that many teachers and parents are facing challenges in coping with the new mode of online teaching and learning. Despite the Indian government increasing its push towards a digital India, a sustained push for digitisation of education delivery and the subsequent (re)training of teachers to deal with this goal, has been lacking. Due to this oversight in preparing for digital education delivery, there has been low investment, in both financial and technological terms, in the education sector as a whole.

Parental support issues: Many children face a difficult home environment where the family may have disharmony and family members may be engaged in altercations with each other. Drishti (2020) continues to suggest that negative home environments can affects the mental health of children and, as such, this can have a direct impact on learning outcomes.

Policies and Government Mandated Directives for the Safety and Education of Children

The Constitution of India guarantees Fundamental Rights to all children in the country and empowers the State to make special provisions for children. The Directive Principles of State Policy specifically guide the State in securing the tender age of children from abuse and ensuring that children are given opportunities and facilities to develop in a healthy manner, in conditions of freedom and dignity. The State is responsible for ensuring that childhood is protected from exploitation and moral and material abandonment.

The National Policy for Children, 2013, was adopted to affirm the Indian government's commitment to the rights based approach in addressing the continuing and emerging challenges in the situation of children. The National Policy for Children, 2013, Recognises that:

- a child is any person below the age of eighteen years
- childhood is an integral part of life with a value of its own
- children are not an homogenous group and their different needs require different responses, especially the multi-dimensional vulnerabilities experienced by children in different circumstances
- a long term, sustainable, multi-sectoral, integrated and inclusive approach is necessary for the overall and harmonious development and protection of children

The National Policy for Children, 2013, reaffirms that:

- every child is unique and a supremely important national asset; special measures and affirmative action are required to diminish or eliminate conditions that cause discrimination

- all children have the right to grow in a family environment, in an atmosphere of happiness, love and understanding
- Families are to be supported by a strong social safety net in caring for and nurturing their children

Although, the policies and government mandated directives for the safety and education of children are clear, there is, as previously described, wide ranging deficits in the current application, attainment and achievement within the education of children and young people. When this is recognised, and put in context with the integrated relationship between education, health and socioeconomic standing (or poverty), the issues become potentially life changing for the individual and risk being socially damaging to the whole country. Ghindra (2020) asserts that education is fundamental to the foundation of society. Playponics can link positively into the relationship between education, health and poverty, though helping children learn about hydroponics through play, supported by an appropriate place in the curriculum. This would allow Playponics to help support local sustainability and promote food growth in a fun and engaging manner that could provide households, schools and communities with the opportunity to grow leafy green vegetables, supporting positive physical health with health-promoting approaches to learning, enriching students' learning experience and provoking their curiosity to future micro economies.

Poverty: Effect on Schools

While India is one of the largest economies in the world, the nation's public education spending does not match other countries with rich economies (Gupta, 2019). In OECD countries, over 11% of the total government spending went to education, on average. However, in India, the same total government spending on education stood at 10.2% in 2016-17 according to the latest Economic Survey.

In 2018-19, India's educational spend had risen to 10.6% of the total government expenditure, the report showed. According to OECD's latest findings, India lags behind several other nations such as the USA, Chile, Mexico, UK, Korea, Israel, etc. in terms of total educational costs. Gupta (2019) reports that based on the Index of Multiple Deprivation report (IMD) India's public education spending has not been enough to either attract foreign talent to the country, or to develop indigenous leading minds, a recent World Talent ranking report by IMD showed. India spends less on education per student than many other countries, with the quality of education also remaining dismal, with India having a large pupil-teacher ratio in primary and secondary education, according to the IMD report.

This has resulted in a massive dip in India's world talent ranking and the country is just ahead of four other nations in attracting and retaining top talent. The IMD has stated that "India ranks 62nd in total public expenditure on education per student and measures of the quality of education (pupil-teacher ratio in primary and in secondary education,". The country spent 3% of its total GDP on education in 2018-19 or about 5.6 lakh crore, the Economic Survey said.

Alcott and Rose (2017) also note that the effects of government under-spending on education and the subsequent impact of poverty on school attendance and engagement. This suggests poverty supersedes all other characteristics as a predictor of learning disparities. Even when controlling for other sources of disadvantage, the gap between the poorest and richest widens through the primary school grades. First-generation school-goers and girls especially, as mentioned earlier, also increasingly fall behind over the primary cycle, although the latter is true predominantly among

poorer children. Poverty is also found to be one of the key drivers of learning gaps across country contexts. Alcott and Rose (2017) also suggest findings on disparities in sub-Saharan Africa (for example), are mirrored in India, where poorer children are far less likely to learn foundational literacy and numeracy skills. An example of this can be seen across rural India, where fewer than 25% of poorer children aged 11–13 are in school and have learned the basics, compared with just half the rate of wealthier children (Alcott and Rose, 2017). However, the National Education Policy (2020) proports to increase state expenditure on education from around 3% to 6% of the GDP as soon as possible.

Languages

Due to India's rich ethnic and cultural diversity, the country does not have a single national language, instead having 22 'official languages', which includes English (Heritage Experiential Learning, 2018). Since the various modern Indian states were formed on linguistic lines, each of the 28 states has its own native language(s) as the official language(s) of the state. English, due to its 'lingua franca' status across India and the world, is an 'aspirational' language for most Indians – for learning English is viewed as a ticket to economic prosperity and social status. Thus almost all private schools in India have English as the medium of instruction. Many public schools however, due to political compulsions, have the state's official languages as the primary school language, with English being introduced as a second language from grade 5 onwards, some states also mandate learning of a non-native third language. This lack of priority to the educational (and world) lingua franca (English) in public schools is one of the major reasons for high enrolment ratios in private schools (44 per cent in rural areas and 65 per cent in urban areas). An overwhelming number of urban and rural parents aspire to ensure that their children master the lingua franca along with their native language (Heritage Experiential Learning , 2018).

Current Practices of English Medium Schools

Proficiency in English is often correlated with higher educational and social standing. Given parental preference for English, many private schools (including low socio-economic status (SES) schools) aggressively focus on building English-speaking skills among children right from nursery grades. Many of these schools adopt a 'total English pedagogy' in which all of formal and informal school interaction is in English through all grades. Many schools also discourage the use of native language by focusing conversation in English and away from the native language – even among peers and friends (Heritage Experiential Learning, 2018).

Many urban schools encourage parents to converse in English even at home. An unintended consequence of this practice is that children may have a negative attitude towards their native languages. On the other hand, government-run public schools focus mainly on native languages. English is introduced as a second language from grade 5, thus presenting a clear competitive disadvantage to students of public schools (Heritage Experiential Learning, 2018). The current practices at the private or public schools are largely driven by economic compulsions, market demands or political compulsions (Heritage Experiential Learning, 2018). However The National Educational Policy (2020) raises the importance of 'mother-tongue' and regional languages as the medium of instruction until grade 5 and preferably beyond,

with Sanskrit and foreign languages also being given importance. The NEP also states that no language will be imposed on the students.

The Indian government clarified that the language policy in the NEP is a broad *guideline* and that it was up to the individual states, institutions and schools to decide upon the implementation. A more detailed language strategy is set to be released in the National Curriculum Framework in 2021 (Gohain, Manash Pratim, 2020).

Section 2: Organisation of Education in India

How Education is Organised at the Local and National Level

India is divided into 28 states and 8 union territories (KnowIndia, no date). The states have their own elected governments while the union territories are ruled directly by the Government of India, with the President of India appointing an administrator for each Union Territory (Kumar, 2011) . As per the constitution of India, school education was originally a state subject, therefore, the states had authority on deciding policies and implementation. School education policies and programmes are suggested at the national level by the Indian government, though the state governments have freedom implementing programmes. Policies are announced at the national level (Kumar, 2011), with the National Council for Educational Research and Training (NCERT) preparing a National Curriculum Framework. Each state has its counterpart called the State Council for Educational Research and Training (SCERT). These are the bodies that essentially propose educational strategies, curricula, pedagogical schemes and evaluation methodologies to the states' departments of education. The SCERTs generally follow guidelines established by the NCERT, though the states have considerable freedom in implementing policies and new curricula into the education system (Kumar, 2011).

The central board and most of the state boards uniformly follow the "10+2" pattern of education (National Council of Educational Research and Training, 1992). In this pattern, study of 10 years is done in schools and 2 years in Junior colleges and then 3 years of study for a bachelor's degree for college. The first 10 years is further subdivided into 4 years of primary education, 6 years of High School followed by 2 years of Junior colleges (Vyas, 2012). The below figure is a useful visual of the current and anticipated educational structure following the release of the National Education Policy (2020)

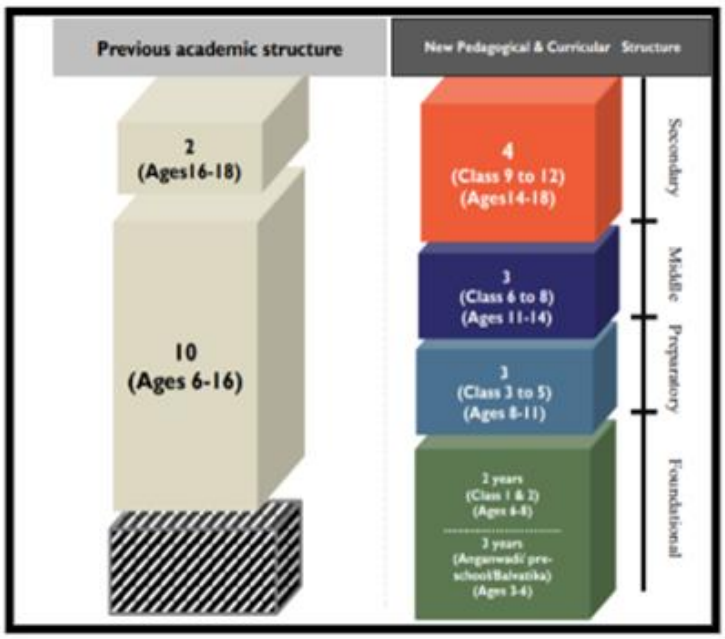

Figure 1: Indian Academic Structure – Old and New (British Council, 2020)

Transitions and Challenges of Changing from the Old Curriculum (2005) to the new National Education Policy (2020)

After 34 years, the new National Education Policy (2020) takes over from and replaces the previous National Policy on Education (1986). The new policy is a comprehensive framework for elementary education to higher education, as well as vocational training in both rural and urban India. The policy aims to transform India's education system by 2021 (Nandini, 2020) although conversely there is suggestion the transition period from the old education policy to the new education policy may take longer with some sources suggesting that national educational policy should be implemented in all schools over India by 2022.

The new National Education Policy recognises the changing world which India finds itself grappling with while trying to prepare for the future, stating:

> "The world is undergoing rapid changes in the knowledge landscape. With various dramatic scientific and technological advances, such as the rise of big data, machine learning, and artificial intelligence, many unskilled jobs worldwide may be taken over by machines, while the need for a skilled workforce, particularly involving mathematics, computer science, and data science, in conjunction with multidisciplinary abilities across the sciences, social sciences, and humanities, will be increasingly in greater demand. With climate change, increasing pollution, and depleting natural resources, there will be a sizeable shift in how we meet the world's energy, water, food, and sanitation needs, again resulting in the need for new skilled labour, particularly in biology, chemistry, physics, agriculture, climate science, and social science (NEP, 2020)".

This recognition of, and focus upon STEM and climate change, along with a recognition of imminent upcoming changes in employment needs provided fertile ground for Playponics to enter the

educational arena, and position itself. Playponics can be tool of innovative and creative learning, scaffolding children's STEM learning and supporting the aspirational New Education Policy (2020).

Some of the changes from the old curriculum (1986) to the new National Education Policy (2020) include:

- **Schooling from 3 years:** According to the New Education Policy, from the age of 3, children will be part of Early Childhood Care and Education (ECCE)
- **Promoting libraries:** A National Book Promotion Policy will be formulated, and extensive initiatives will be undertaken to ensure the availability, accessibility, quality, and readership of books across geographies, languages, levels, and genres
- **Teaching up to class 5 in the mother tongue/regional language:** in addition Sanskrit will be offered at all levels and foreign languages from the secondary school level
- **Creating Bal Bhavans:** Every state or district will be encouraged to establish 'Bal Bhavans' as a special daytime boarding school, to participate in art-related, career-related, and play-related activities
- **minimum degree qualification for teaching:** by 2030 a 4-year integrated B.Ed. degree will be required
- **Easing of board exam:** The board exams for class 10 and 12 will continue. However, the board exams will be made 'easier' as they will primarily test core capacities and competencies rather than months of coaching or memorisation
- **Changes in report card:** The progress card of all students for school-based assessment will be redesigned. It will be a holistic, 360-degree, multidimensional report card that will reflect in great detail the progress and uniqueness of each learner in the cognitive, affective, and psychomotor domains. The progress card will include self-assessment, peer assessment, and teacher assessment
- **NEP ends science-commerce-arts streams:** NEP has eliminated the rigid separation of streams. Students will now be able to choose subjects like history and physics at the same time in class 11 and
- **National Educational Technology Forum:** An autonomous body, the National Educational Technology Forum (NETF), will be created to provide a platform for the free exchange of ideas on the use of technology to enhance learning, assessment, planning and administration (Business Today, 2020)

Section 3: Playponics Pedagogic Potential: Intent and Reality

Playponics: a definition

Playponics is a new concept in sustainable education, defined as the integration of sustainable education blended across Science, technology, Engineering, Maths (STEM) melding hydroponics technology into children's outdoor play equipment. This resource will utilise children's natural engagement with play such as swings, see-saw, barrel run, etc. to harness their kinetic energy. This harnessed energy channelled through the equipment, moves water and nutrients through the

hydroponics system. This will facilitate children's play while also harnessing this play into supporting the growth of plants that can be used as a source of food within schools and local communities.

Playponics is suitable for a wide age range of children and young people and will facilitate engagement with the natural world though play and curiosity. Additionally, important educational subjects such as Science, Technology, Engineering and Maths (STEM), along with subjects such as sustainability, health, community, and collaborative learning can be grounded, explored and illustrated through the Playponics equipment, and the plants and food it produces.

Aim of Playponics:

Playponics is a new development on classic hydroponics technology. Hydroponics can be defined as the science of growing plants without using soil, by feeding them on mineral nutrient salts dissolved in water. "hydroponics can be a plant growing in a pot of inert aggregate (such as perlite) and given water containing a liquid fertiliser from a watering source sufficiently often that is does not dry out. The spaces between the aggregate contain air so that roots do not suffocate… Many plants are usually watered via a drip system fed with a pump from a stock tank of nutrient solution. The nutrient solution can run to waste but it is less expensive, and less potentially polluting, to recirculate the nutrient solution via a trough below the plants that runs back to the stock tank." (Royal Horticulture Society, 2020).

The hydroponics concept is then joined with children's outdoor play equipment such as swings, barrel runs, seesaws, etc. that are designed to aid in the pumping of the liquid fertiliser to feed the plants in the hydroponics unit. Thereby children are actively engaged in ergonomic and kinaesthetic physical play that facilities the growth of leafy green plants. This, placed within a learning environment such as a school or community, can support education subject application. Thereby, Playponics is a tool suitable for a wide age range of children and young people, to facilitate engagement with the natural world and educational subjects across STEM. Another avenue of educational enhancement which can be derived from the use and integration of Playponics equipment in a school or community setting is sustainability, health, community, and collaborative learning.

The Playponics system also fits into the compulsory Environmental Education (EE) Policy that requires environmental consideration and education to be infused into the national formal education system, which provides education for students ages 6 – 18. This infused approach necessitates the integration of EE within the existing curriculum utilising many subject areas and developing project-based activities.

The new National Education Policy (2020) and the current Indian National Curriculum (NCF) (2005) have a focus on Environmental Education (EE) thus supporting the existing EE policy (2010) as an instrument to promote critical thinking and problem-solving approaches, as opposed to memorizing textbook content. This is a clear attempt by the Indian government to move away from rote type learning previously popular as a teaching method in the Indian Education System. "This approach recognizes that holistic thinking is at the heart of EE, which aligns with the new NCF infusion paradigm intended to replace sectoral thinking with multidisciplinary thinking to promote environmental understanding and actions" (GEEP, 2010). It is assumed that the updated Indian National Curriculum (2021) which was due for release in March 2021 and has been delayed will continue to progress the innovative efforts of the National Education Policy (2020) and Environmental Policy (2010) to bring innovative change to the subjects taught and pedagogical

approach to learning, with student centred teaching and learning at its core. The student centred teaching approach will continue to provide a space for the Playponics system to provide a rich learning opportunity and act as a vehicle to enhance academic learning and support and illustrate Environmental Education.

Ultimately, at the heart of Playponics is the belief that play is vitally important in children's learning, and that Playponics provides a unique and innovative way to intertwine play with learning pertinent subject knowledge. This integration of play and specific subject knowledge has the potential to be life-altering. Through interlinking education with a health and environmental focus, centred on plant husbandry and STEM, children are better integrated into understanding vegetables, nutrition and natural sciences, while the physical elements of Playponics support mental and physical health. Ken Robinson cited in Sahlberg and Doyle (2019), argues that "child's play may be highly enjoyable, but it is not trivial. To grow and thrive, children have to play. Active, physical play is a primary way that children learn about themselves and the world around them". This argument of the value of play is furthered by Sahlberg and Doyle (2019) themselves: "Play is a huge open window through which a life-giving stream of concepts and ideas pours into the child's spiritual world. Play is a spark igniting the fires of inquisitiveness and curiosity".

Simply put, Playponics provides the vehicle of learning to ignite curiosity, train problem solving and grow individually and collaboratively as a community within a classroom, village or family; the application of hydroponics has wide reaching application.

Link to the current National Curriculum (2005) – Exemplar collated framework evidencing the relationship between Playponics outcomes and potential synthesis with the national curriculum 2005 principles:

The British Council (2019) reports that the current design of educational provision in the school sector is governed by the National Curriculum Framework last updated in 2005 but expected to be revised in 2020-21 (not yet released).

"The framework sets out five broad principles:

1. connecting knowledge to life outside the school

2. ensuring that learning shifts away from rote methods

3. enriching the curriculum so that it goes beyond textbooks

4. making examinations more flexible and integrating them with classroom life, and

5. nurturing an overriding identity informed by caring concerns within the democratic polity of the country' (p. viii)." (British Council, 2019)

The Playponics system could support these principles through the following potential application (see table 1. below for NCF principal collation framework with hydroponics, this is brief and intended as an overview only):

Table 1: NCF Principal Collation Framework With Hydroponics

National Curriculum Framework (2005)	Playponics System Application
Connecting knowledge to life outside the school	Application to the curriculum in subjects such as:

	➢ Science(Biology/Chemistry/Physics) ➢ Mathematics ➢ Computers (CAD/Engineering/ Design) ➢ Environmental Education (Infused approach across all subjects) ➢ Health and Physical education ➢ Study of Peace ➢ Work and Education
Ensuring that learning shifts away from rote methods	Collaborative Learning (Proximal development theory) Experiential Learning (Kholb, 1984) Action Learning Facilitation Theory (humanist approach) Reinforcement Theory (Oxford Brooks, 2002) Situated Learning Theory and Community of Practice (UNESCO, 2020)
Enriching the curriculum so that it goes beyond textbooks	There are a plethora of examples of activity led learning to move current learning methods away from rote and textbook based knowledge acquisition. These include: ➢ Project work ➢ Group work ➢ Poster creation and presentation ➢ Reflections ➢ Portfolios ➢ Discussion ➢ Hydroponic system design/draft skills/ drawing skills ➢ Business plans SWAT analysis etc.
Making examinations more flexible and integrating them with classroom life	➢ **Diagnostic assessments** e.g. mind maps, flow charts, KWL charts, short quizzes, journal entries, student interviews, student reflections, graphic organizers, classroom discussions ➢ **Formative assessments** e.g. Portfolios, Group projects, Progress reports, Class discussions, Entry and exit tickets, Short, regular quizzes, Virtual classroom tools like Socrative or Kahoot! ➢ **Summative assessments** e.g. Recording a podcast, Writing a script for a short play, Producing an independent study project ➢ **Ipsative assessments** (two stage assessment with student reflection in-between) e.g. Portfolios, A two-stage testing process, Project-based learning activities (Kampen, 2020)
Nurturing an overriding identity informed by caring concerns within the democratic polity of the country' (p. viii).	Playponics can help with this part of the National Curriculum Framework by encouraging:

	➢ Collaborative approach to study and learning outcome ➢ Awareness of community and family ➢ Application of sustainability technical skills and knowledge for the betterment of community/school/ family ➢ Understanding of the natural world, social connectivity through project work and outcomes

Link to Core Subjects (2005) – Exemplar collated framework evidencing the relationship between outcomes and potential synthesis with the current national curriculum 2005 subject:

A more detailed outline of anticipated Playponics impact with the national curriculum is below, in Table 2. There are nine suggested subject areas within the NCF (2005), with these being Language, Mathematics, Computers, Science, Social Science, Art Education, Health Education and Physical Education, Study of Peace, and Work and Education. Environmental Education is not a subject in its own right due to the Indian government's wish for it to be taught via an infused approach, threaded through all subjects, where possible. Seven out of the above nine subjects were deemed easily connectable to the Playponics system in terms of supporting and enhancing a variety of learning outcomes. However, further examination and consideration for more specific stages of the curriculum, is to be done so that Playponics can be better tailored to specific learning outcomes by year, ability groups, and assessment needs.

Table 2: Framework Overview Of Relationship Of Playponics To Core Curriculum Subjects

National Curriculum (2005) Subjects	NCF (2005) Subject Aims	Potential Playponics Application to the Subject
Science (Chemistry; Physics; Biology)	To acquire skills and understand the methods and processes that lead to generation and validation of scientific knowledge. To develop a historical and developmental perspective of science and to enable the student to view science as a social enterprise. To relate to the local as well as global, and appreciate the issues at the interface of science, technology and society. To acquire the requisite theoretical knowledge and practical technological skills to enter the world of work. To nurture the natural curiosity, aesthetic sense and creativity in science and technology	➢ Plan and undertake scientific experiment of plant life cycle ➢ Identify plant parts, name and label ➢ Design small research project around growing different plants ➢ Understand nutrients needed to feed and grow plant for food usage
Mathematics	mathematics learning models through pedagogy which devotes a greater percentage of instructional time to problem	➢ Working out ratios of titration of nutrients for plants ➢ Working out amount of play usage

	solving and active learning. Mathematics makes a learner systematic, confidential, self evaluated, self esteem, self reliable	e.g how many swings moves how much water, etc.
Computers (CAD; Engineering; Design)	To move from a predetermined set of outcomes and skill sets to one that enables students to develop 16 explanatory reasoning and other higher-order skills. To Enable students to access sources of knowledge, interpret them, and create knowledge rather than be passive users	➢ Design using 2D skills an indoor aesthetically pleasing hydroponics unit for low mobility users ➢ Design a 2D/3D outdoor hydroponics unit that could enhance the Playponics unit
Environmental Education (Infused approach across all subjects)	**Classes I and II (ages 6-7):** EE is taught through activities integrated into the core subjects of reading, writing, and mathematics. For example, students may study shapes in mathematics by identifying shapes in the natural environment **b. Classes III to V (ages 8-11):** EE is taught as a standalone subject, called Environmental Studies (EVS), with a textbook called My Environment that aims for students to learn about the environment in the context of their own lives and communities. **c. Classes VI to X (ages 12-16):** EE is taught by the infusion approach primarily in science and social sciences. For example, students studying decomposition in science might complete an EE-related project as part of the learning unit. In all subjects, EE-based questions comprise ten percent of the total marks for both formative and summative assessments. **d. Classes XI and XII (ages 17-18):** EE is part of students' Interdisciplinary Projects in electives and General Studies as students choose their own disciplines	➢ Maths related to Playponics titration ➢ Maths related to design of a Playponics unit ➢ Maths related to water or play needed to cycle water to feed plants. ➢ Sustainability of water usage and growth rates of plants. ➢ EE related project linked to Playponics, food security, food distribution, food nutrition, health and food issues such as anaemia ➢ Interdisciplinary project related to food growth rate and household consumption etc.
Health and Physical Education	To provide theoretical and practical inputs to provide an integrated and holistic understanding of health, disease, accidents and physical fitness among children. To provide skills for dealing with psycho-social issues in the school, home and the community. To help children grow as responsible citizens by inculcating in them certain social and moral values through games, sports, N.C.C., Red Cross, Scouts & Guides, etc.	➢ Examine physical benefits of children on swings/see-saw, barrel run etc. ➢ Examine the benefits of Playponics use on mental health of users ➢ Investigate and present findings on psycho- social impacts of Playponics system within the school community
Study of Peace	Skills that are developed as part of curriculum of activity such as to listening with patience and endurance, purity of mind to develop concentration, aptitude for cooperation and teamwork, to reach out to get answers (curiosity and rational inquiry),	➢ Group work ➢ Pair work ➢ Collaborative care of a Playponics unit ➢ Collaborative work on plant husbandry for a Playponics unit

	acceptance of discipline, and a positive attitude to study/work are the trademarks of a good student which in turn are also the skills of a peace-oriented person. Thus the curriculum also inculcates peace and democracy into students	➢ Students democratic work on deciding the use and distribution of plants grown from the Playponics system, e.g. which class or group of people get the food which is grown
Work and Education	Work related education is made as an integral component of the school curriculum, in the form of – work experience, work education, SUPW, craft education, life oriented education, pre vocational education and generic education. Work based education aims at involving children in a variety of production or service oriented activities, to develop skills, positive attitudes and values through work and also to develop work related competencies	➢ Develop business innovation skills – grow and sell plants grown using the Playponics system ➢ Examine cost and profit margins ➢ Service to local communities with distribution of leafy green vegetables

Playponics Potential to Support Indian Government Education Policy:

The Indian Government is committed to educational change which in turn will hopefully lead to fundamental social change for the betterment of the inhabitants of India; this will take time. However, the changes suggested within the National Education Policy (2020), the Environmental Education Policy (2010) and the soon to be released National Curriculum Framework for School Education (NCFSE) anticipated in March 2021 – though yet not yet released- will go a long way to supporting these aspirations.

The Hydroponics/Playponics system is a unique opportunity to put theory into practise. When the Playponics system is used as a physical learning resource, and integrated into the curriculum, a further enhancement of the Indian government's commitment to move away from rote learning can be attained. This use of Playponics will also further help in embedding environmental education and core sustainability concepts into a practical application through hands on learning.

The new National Education Policy (2020) has suggested multiple changes in approach, application and educational delivery from the previous education policy. Below are the changes that provide a unique opportunity for Playponics to enhance the NEP 2020, educational experience and learning, while also providing a vehicle for staff to enhance teaching pedagogy and delivery (see Table 3).

Table. 3 New National Education Policy (2020) Changes that Correlate with the Playponics System:

New National Education Policy 2020 changes	Playponics system focus
Schooling from 3 years: According to the New Education Policy, from the age of 3, children will be part of Early Childhood Care and Education (ECCE)	The Playponics system will work well with this age group – potential for wider number of users and stakeholder involvement as education provision grows
Creating Bal Bhavans: Every state or district will be encouraged to establish 'Bal Bhavans' as a special daytime boarding school, to participate in art-related, career-related, and play-related activities	Play-related, career-related opportunities expands the potential to use Playponics in these areas with STEM and play

Changes in report card: The progress card of all students for school-based assessment will be redesigned. It will be a holistic, 360-degree, multidimensional report card that will reflect in great detail the progress and uniqueness of each learner in the cognitive, affective, and psychomotor domains. The progress card will include self-assessment, peer assessment, and teacher assessment	Playponics can be utilised within peer related activities and peer related assessment, collaborative work, being part of an holistic approach to learning and assessment
NEP ends science-commerce-arts streams: NEP has eliminated the rigid separation of streams. Students will now be able to choose subjects like history and physics at the same time in class 11 and 12	Greater student-centric learning options will allow students to opt for subjects where they can use the Playponics system – creating opportunities for increased engagement with resource and class attendance
National Educational Technology Forum: An autonomous body, the National Educational Technology Forum (NETF), will be created to provide a platform for the free exchange of ideas on the use of technology to enhance learning, assessment, planning, and administration (Business Today, 2020)	Opportunity for Playponics to build relationships with the NET forum for idea exchange and enhanced learning opportunities

Potential for Playponics to Support United Nations Development Goals 4 and 17:

The British Council (2021) have reported that the NEP is the first education policy of the 21st century to be written in line with the UN's 4th development goal, stating: "[The NEP] attempts to align the development imperatives of India with UN Sustainable Development Goal 4 as well as to the country's knowledge ambitions" (British Council 2021).

The United Nations development goal 4 states: "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all". Playponics, due to its suitability for varying age ranges, curriculum stages and linking with STEM subjects within an educational setting and/or community setting, supports this development goal of inclusivity in the promotion of education. The British council (2021) also suggest that the National Educational Policy (2020) also affords an opportunity to further strengthen existing India-UK educational links to innovate, embed and expand the skills based creativity in school education.

Playponics provides a clear correlation with UNSDG 4 due to its rich educational impetus along with supporting the goals and aspirations of Indias government for educational enhancement and knowledge acquisition. With India's NEP (2020), and the British Council's ambitions of strengthened India-UK educational links to aid innovation and grow the skill-base of children and young people in education though entrenched creativity within the school system, Playponics can be used as a suitable resource to aid meeting this end.

Playponics continues with a strong correlation to the United Nations Sustainable Development Goal (UNSDG) number 17 which states a desire to "Strengthen the means of implementation and revitalize the global partnership for sustainable development" (UN, 2020). This can be done through a verity of means including 'Multi stakeholder partnerships and voluntary commitments' which the

United nations explains as meanings: “It require different sectors and actors working together in an integrated manner by pooling financial resources, knowledge and expertise…Partnerships for sustainable development are multi-stakeholder initiatives voluntarily undertaken by Governments, intergovernmental organizations, major groups and other stakeholders, which efforts are contributing to the implementation of inter-governmentally agreed development goals and commitments, as included in Agenda 21”(UN, 2020).

Playponics could act as a stakeholder, as outlined above, to aid in achieving this sharing of knowledge and expertise of design-led hydroponics play systems, and the integrated educational teaching and learning benefits that result from such innovative systems as Playponics.

The UNSDG 17 also suggests that technology can play a key role in strengthening the means of implementations and achieving sustainable development, stating “technology, science and capacity building are major pillars of the Means of Implementation of the Post-2015 Agenda and of the Rio+20 follow-up processes. The research, development, deployment, and widespread diffusion of environmentally sound technologies in the context of a Green Economy is also closely linked to other core elements and means of implementation, including innovation, business opportunities and development, trade of environmental goods and services, finance and investment, and institutional capabilities” (UN, 2020).

Playponics could, through its use of environmentally sound science, engineering and technology, act as a wide spread educational tool to diffuse the knowledge and understanding of hydroponics to schools and communities, enhancing social knowledge of sustainable plant growth while developing an opportunity for the green economy from the ground up in otherwise impoverished schools and communities. Furthermore, UNSDG 17 also specifically identifies Science as another key participant in the matrix of achieving sustainable development. The UN (2020) also reports that **“**Science for sustainable development is the focus of Chapter 35 of Agenda 21, where It calls for:

- strengthening the scientific basis for sustainable management;
- enhancing scientific understanding;
- improving long-term scientific assessment; and
- building up scientific capacity and capability.” (UN, 2020)

Playponics could support the ‘enhancement of scientific understanding’ by providing schools, children and young people of all ages, the opportunity to participate in student centred kinaesthetic science and technology in action, through working with and learning about the science behind the application of hydroponics and agriculture/botany. This education can be managed to meet the requirements of many stages of the national curriculum and assessment for both 2005 version and the anticipated new National Curriculum, as outlined earlier.

Potential Pedagogy with Playponics

Pedagogy, as defined by the Cambridge dictionary (2021), is “the study of the methods and the activity of teaching”. This is important in relation to the implementation of Playponics as, in order to enable a strong supporting integration to the current national curriculum (2005) and to the soon to be updated version of this curriculum, an appropriate learning outcome and teaching mode grounded on the use of Playponics needs to be envisioned and defined. As both the current national curriculum (2005) and the new National Education Policy (2020) discuss the aspiration of moving away from a more singular focused ‘rote’ based model of learning, towards a more student centred

style of teaching and learning that provides opportunities for multiple learning modes, Playponics can be used to enhance, support and enable the fulfilment of the desired child-centric learning pedagogy.

Sharples (2019) proports "Humans are remarkable learning systems. We learn by imitation, instruction, conversation, self-reflection and exploration. Our learning starts at birth and continues throughout our lives. On average, adults engage in 13-17 hours per week of active learning". It can easily be argued that children engage in more learning hours than this. Sharples (2019) continues to suggest that sitting young people behind a desk in a classroom and instructing them in a topic and examining them on recall only, is highly inefficient and does little to prepare them for work and life. Active play, curiosity and problem solving, which can be directly grounded in the use of Playponics systems however, can have useful transferable skills into adulthood. Due to this, and the Indian government's desire to move away from it, the rote model of learning will not be included within this report.

Therefore, suitable pedagogies that work fluidly with Playponics and meld the National Curriculum (both current and to be released) as well as the NEP's (2020) goals for having student centred learning is imperative when considering the installation and integration of a Playponics system within a school. The following pedagogies have been selected based upon the unique innovations of the Playponics system and the aims of the NEP (2020) and current National Curriculum (2005) assuming that the soon to be released national curriculum will have its aims and themes harmonise alongside the NEP (2020).

Potential pedagogies most suited to Playponics and brief suggestions of links to the above 2005 National Curriculum (abbreviated below to NC) and/or the NEP (2020) are placed into themes and highlighted in the table below to provide an indicative overview of the positive relationship between the three:

Table 3: Potential Pedagogy with Playponics

Theme 1 - Connectivity: learning among people and locations	**Link to National Curriculum (2005)**	**Link to National Education Policy (2020)**
Pedagogy - Crossover learning: learners may begin an investigation in class, instigated by the teacher then continue this outdoors, and at home, where they can use mobile devices such as smart phones to collect evidence such as relevant data then share/present in the classroom (Sharples, 2019).	This can relates to all STEM subject areas outlined in the NC.	The NEP (2020) goal of updating report cards: The progress card of all students for school-based assessment will be redesigned. It will be a holistic, 360-degree, multidimensional report card that will reflect in great detail the progress and uniqueness of each learner in the cognitive, affective, and psychomotor domains. The progress card will include self-assessment, peer assessment, and teacher assessment. NEP ends science-commerce-arts streams: NEP has eliminated the rigid separation of streams. Students will now be able to choose subjects like history and physics at the same time in class 11 and 12
Pedagogy - Seamless learning: involves the connection and relationship of learning encounters across social settings, different	**NC (2005)** Health and physical education: To provide theoretical and practical inputs to provide an integrated and holistic understanding	**NEP (2020)** ends science-commerce-arts streams: NEP has eliminated the rigid separation of streams. Students will now be able to choose subjects

locations, devices and times (Sharples, 2019).	of health, disease, accidents and physical fitness among children. To provide skills for dealing with psycho-social issues in the school, home and the community. To help children grow as responsible citizens by inculcating in them certain social and moral values through games, sports, N.C.C., Red Cross, Scouts & Guides, etc.	like history and physics at the same time in class 11 and 12
Pedagogy - Learning through Social media: This mode enables the engagement with social platforms such as Facebook, YouTube, Pinterest, Twitter, etc. (Sharples, 2019). Interestingly Indian social media usage states are as follows Face book 84.16 %, YouTube 7.9%, Pinterest 3.53% and Twitter 2.54% (Global Stats, 2021).	**NC (2005) Study of Peace:** Skills that are developed as part of curriculum activity such as to listening with patience and endurance, purity of mind to develop concentration, aptitude for cooperation and teamwork, to reach out to get answers (curiosity and rational inquiry), acceptance of discipline, and a positive attitude to study/work are the trademarks of a good student which in turn are also the skills of a peace-oriented person. Thus the curriculum also inculcates peace and democracy into students	**NEP (2020)** Changes in report card: The progress card of all students for school-based assessment will be redesigned. It will be a holistic, 360-degree, multidimensional report card that will reflect in great detail the progress and uniqueness of each learner in the cognitive, affective, and psychomotor domains. The progress card will include self-assessment, peer assessment, and teacher assessment. **NEP (2020) ends science-commerce-arts streams:** NEP has eliminated the rigid separation of streams. Students will now be able to choose subjects like history and physics at the same time in class 11 and 12.
Pedagogy - Navigating Knowledge: Tackling this challenge of navigating knowledge by supporting students to understand the nature of knowledge (epistemology) and to enable them to differentiate truth from falsehood, actual evidence from quackery (Sharples, 2019).	**NC (2005) Study of Peace:** Skills that are developed as part of curriculum activity such as to listening with patience and endurance, purity of mind to develop concentration, aptitude for cooperation and teamwork, to reach out to get answers (curiosity and rational inquiry), acceptance of discipline, and a positive attitude to study/work are the trademarks of a good student which in turn are also the skills of a peace-oriented person. Thus the curriculum also inculcates peace and democracy into students	**NEP (2020) ends science-commerce-arts streams:** NEP has eliminated the rigid separation of streams. Students will now be able to choose subjects like history and physics at the same time in class 11 and 12
Theme 2 - Reflection: Knowledge comes from reflection and contemplation, allowing us students to engage with learning through reading or experimentation for example producing new information and then being able to reflect and contemplate this information synthesising with existing knowledge and developing understanding of concepts and knowledge.	**Link to National Curriculum (2005)**	**Link to National Education Policy (2020)**
Pedagogy - Explore First: assists students to start new topics by exploring the scope, attempting to problem solve and reflecting on success and or failure before prior to formal teaching (Sharples, 2019).		**NEP (2020) ends science-commerce-arts streams:** NEP has eliminated the rigid separation of streams. Students will now be able to choose subjects like history and physics at the same time in class 11 and 12
Pedagogy - Teachback: supports	**NC (2005):** This can relates to all	

reflection by having a learner explain their knowledge of a topic to another, then the receiving student learner teaches it back to the original learner. This can also be extended to groups and formally structure via argumentation, students can explore and then explain their reflective process to another and or groups in what is considered a collaborative process of dialogue and investigations (Sharples, 2019).	STEM subject areas outlined in the NC.	
Pedagogy - Assessment for learning: Focuses on the student to identify their own learning difficulties, identify suitable resources and plan to overcome these difficulties. This could be formative type of activity to enable knowledge gaps and steps to fill these gaps of learning (Sharples, 2019).		**NEP (2020) Changes in report card:** The progress card of all students for school-based assessment will be redesigned. It will be a holistic, 360-degree, multidimensional report card that will reflect in great detail the progress and uniqueness of each learner in the cognitive, affective, and psychomotor domains. The progress card will include self-assessment, peer assessment, and teacher assessment.
Theme 3 - Extension: These innovative pedagogy modes extend the current scope of teaching methods by supporting them and aiding in strengthening their weaknesses.	**Link to National Curriculum (2005)**	**Link to National Education Policy (2020)**
Pedagogy - Threshold Concepts: open up new ways of thinking about problems. This can include threshold concepts such as 'heat transfer' or 'centre of gravity' which in turn inform everyday activities such as cooking and sports (Sharples, 2019).		**NEP (2020) Changes in report card:** The progress card of all students for school-based assessment will be redesigned. It will be a holistic, 360-degree, multidimensional report card that will reflect in great detail the progress and uniqueness of each learner in the cognitive, affective, and psychomotor domains. The progress card will include self-assessment, peer assessment, and teacher assessment.
Pedagogy - Learning through wonder: encourages students to find wonder in in everyday objects and provokes a voyage of examination, discovery and curiosity (Sharples, 2019).		**NEP (2020):** 'Bal Bhavans' as a special daytime boarding school, to participate in art-related, career-related, and play-related activities.
Pedagogy - Context based learning and Event based learning: this brings the experience of learning process to the most immediate relevant issues (Sharples, 2019).		**NEP (2020) ends science-commerce-arts streams:** NEP has eliminated the rigid separation of streams. Students will now be able to choose subjects like history and physics at the same time in class 11 and 12
Theme 4 - Embodiment: opposite to abstract learning, embodied learning requires students to recognise the human experience and bodies that we are used to create, craft, construct and explore.	**Link to National Curriculum (2005)**	**Link to National Education Policy (2020)**

Pedagogy - Maker culture: includes traditional making such as weaving, pottery, leather crafts, jewellery design but more modern activities of 3D printing, CAD design and invention, etc. (Sharples, 2019).	**NC (2005) Science/Biology/Chemistry/ Physics:** To acquire skills and understand the methods and processes that lead to generation and validation of scientific knowledge. To develop a historical and developmental perspective of science and to enable her to view science as a social enterprise. To relate to the, local as well as global, and appreciate the issues at the interface of science, technology and society. To acquire the requisite theoretical knowledge and practical technological skills to enter the world of work. To nurture the natural curiosity, aesthetic sense and creativity in science and technology.	**NEP (2020):** 'Bal Bhavans' as a special daytime boarding school, to participate in art-related, career-related, and play-related activities.
Pedagogy - Design Thinking: incorporates Bricolage as a pedagogy although these can also be separate. Design thinking is bricolage and reflection combined into a process of creation that incorporates planning designing, testing and redesigning with an iterative aspect (Sharples, 2019).	**NC (2005) Science/Biology/Chemistry/ Physics:** To acquire skills and understand the methods and processes that lead to generation and validation of scientific knowledge. To develop a historical and developmental perspective of science and to enable her to view science as a social enterprise. To relate to the, local as well as global, and appreciate the issues at the interface of science, technology and society. To acquire the requisite theoretical knowledge and practical technological skills to enter the world of work. To nurture the natural curiosity, aesthetic sense and creativity in science and technology. **NC (2005)** This can relates to all STEM subject areas.	**NEP (2020):** 'Bal Bhavans' as a special daytime boarding school, to participate in art-related, career-related, and play-related activities. **NEP (2020) Changes in report card:** The progress card of all students for school-based assessment will be redesigned. It will be a holistic, 360-degree, multidimensional report card that will reflect in great detail the progress and uniqueness of each learner in the cognitive, affective, and psychomotor domains. The progress card will include self-assessment, peer assessment, and teacher assessment.
Theme 5 - Scale: Relates to learning being delivered on a massive scale such as 'Massive Open Online Courses'(MOOC), that allows large numbers of people to engage with the material. While Playponics is not currently linked to any MOOC there is scope that existing Mooc's could enhance any aspect of STEM knowledge directly relatable to Playponics and therefore worth consideration under specific guidelines.	**Link to National Curriculum (2005)**	**Link to National Education Policy (2020)**
Pedagogy - Citizen Enquiry: members of communities, this could include families of children within the schools to propose and engage in research(Sharples, 2019).		**NEP (2020):** The members of the community could be family members of school students proposing problems for the children to research and resolve in relation to Playponics such as food insecurity etc.

Pedagogy - Rhizomatic learning: Students work together in vibrant manners to ascertain their own curriculum and preferred modes of learning (Sharples, 2019).		**NEP ends science-commerce-arts streams:** NEP has eliminated the rigid separation of streams. Students will now be able to choose subjects like history and physics at the same time in class 11 and 12

Potential Learning Theories with Playponics

Learning theories can be defined as "as a set of different concepts that observe, describe, explain, and guide the learning process of people and everything that relates to this process" (Royal, 2019). There are myriad themes of learning theories, such as Classical learning theories, contemporary learning theories, early childhood and development theories and theories that underpin curriculum development and planning, assessment and evaluation. Due to this vast array of potential teaching theories, this report recognises the difficulty in sifting through and discussing these in relation to Playponics, as too many factors affect the selection of appropriate theory and application such as localisation, age and stage of students, topic of study and the teachers level of education, knowledge, experience, interest, motivation and time available of the teacher involved in lesson planning, in addition to the culture of the school and support of line management in using differing concepts.

However, it is worth mentioning Lev Vygotsky's Scaffolding – Zone of proximal Development, which can be described as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers". This is illustrated in figure 2, below:

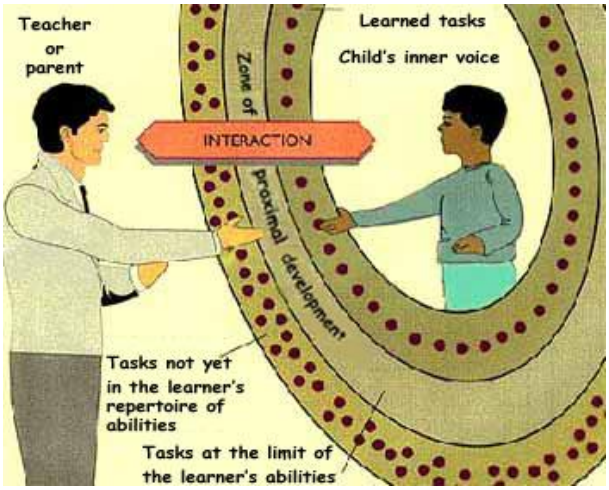

Figure 2: Teaching Model based on Vygotsky's theory of proximal development

The principles underpinning Vygotsky's scaffolding are as follows:

- Build interest in the subject and engage with people
- Break the given task into smaller sub-tasks
- Keep the individual or group focused on completing the sub tasks but maintain interest on core task
- Use Most knowledgeable others to support learners (MKO can be staff or older students, or guest speakers)

- Model potential ways to complete tasks which learners can model and internalise (Bates, 2019)

This learning theory is easy to use and applicable to multiple ages and stages of learning, providing a robust cognitivist approach to learning that incorporates a kinaesthetic approach to learning through Playponics, if adopted by teaching staff.

Another learning theory that may be suitable to older students, which is again supportive of Playponics as a collaborative activity that provokes inquiry and reflection, is Argyris and Schon's triple loop learning theory. Argyris and Schon propose that individual learning can be categorized into a three stage model of single, double and triple-loop learning (Bates, 2019) See image below:

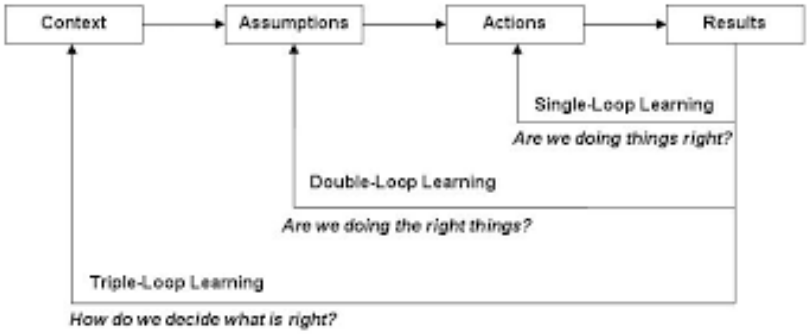

Figure 3: Triple loop learning model (Bates, 2019)

The determinants of single, double and triple loop learning are as follows:

- Single-loop learning: is the first level of performance measurement. It focuses on actions and asks the questions, 'are we doing this right'
- Double-loop learning: is centred on quality assurance, focusing on error prevention and asks 'are we doing the right things'?
- Triple-loop learning: represents a reflective focus with self-examination, addressing the concept of the activity and of the learner and what they want it to be and asks 'how can we be sure what's right is right?' (Bates, 2019)

This could be used when engaging older students with self-reflection enquiry, along with student centred activities and lesson plans in a wide range of subjects, which have been applied to the Playponics resource, again supporting the NEP (2020) and the NC (2005).

Localisation Considerations

The concept of localisation is perhaps one of the most impactful when considering education and its transferability to another location or country. Localisation describes the "process of taking educational resources developed for one context and adapting them for other contexts. These contexts can, for example, be geographical, pedagogical, political, or technical. The practice of localization encompasses more than the translation of materials into a local language or swapping a photo to reflect a culture" (Perryman, Hemmings-Buckler and Seal, 2014).

Localisation is a term that has most notable been applied to open educational resources (OER) and aims to place diversity, openness, and reusability at the heart of the practise of OER.

Perryman, Hemmings-Buckler and Seal (2014) report "No matter where you live or what you teach, when you modify open and freely shared materials for your own use, you are localizing the materials. There are many reasons why educators and learners localize materials. Here are a few:

- To address a particular teaching style or learning style
- To adapt for a different grade level
- To adapt for a different discipline
- To adjust for a different learning environment
- To address diversity needs
- To address a cultural preference
- To support a specific pedagogical need
- To address either a school or a district's standardized curriculum"

There is little written on the transferability of educational resources and localisation internationally. As such, this report will use the findings and recommendations of the Perryman, Hemmings-Buckler and Seal (2014) Open University-UK led Million pound project's initial approach to localisation when creating teaching materials for Teacher Education Through School Based Support (TESS-India) and the challenges they faced in the localisation of teaching materials and resources Doing so should prove helpful in informing the localisation considerations for Playponics going forward.

Perryman, Hemmings-Buckler and Seal (2014) highlight the multiple complexities of managing translation. They also raise the need to effectively navigate localisers perceptions, and perhaps mis-perceptions, preferences and professional experience (or lack thereof). Both educators and localisers (these could be considered local stakeholders such as teachers, school admin staff, etc.) unfamiliarity with new resources and teaching materials, can cause new or recontextualised resources to be under-used, or lack in effectiveness. This unfamiliarity can be readily applied to Playponics as a new, innovative resources, which combines STEM subjects and play. Barriers to engagement with this new learning resource (in this case consider that Playponics may face these) included hierarchical understandings around knowledge ownership and localisers subsequent reluctance to adapt and fully engage with new teaching resources.

Additional factors to be aware of when considering localisation of teaching materials and resources for Playponics is the concept that some local participants (teachers, etc.) involved in the Playponics programme may hold the notion that that the notion of knowledge partnerships is a UK-led project, irrespective of whether the materials, lesson plans and aligned resources are written collaboratively with Indian educators, questioning if these are supportive of national policies and nationally endorsed pedagogical approaches, or is a form of neo-colonialism. This view is not uncommon and was experienced by Perryman, Hemmings-Buckler and Seal's (2014) research team, who suggested that an awareness was needed that development projects could be viewed as 'the rich north [pushing] resources at the poor south' without thought of reciprocity (Glennie et al 2012).

However when considering this, these challenges adopting Wildes (2012 cited in Perryman, Hemmings-Buckler and Seal (2014) engagement ladder highlights the greater the level of shared co production and knowledge partnership in developing reflective engagement the decrease in concern of neo-colonialism occurs and increase in project engagement. See image below:

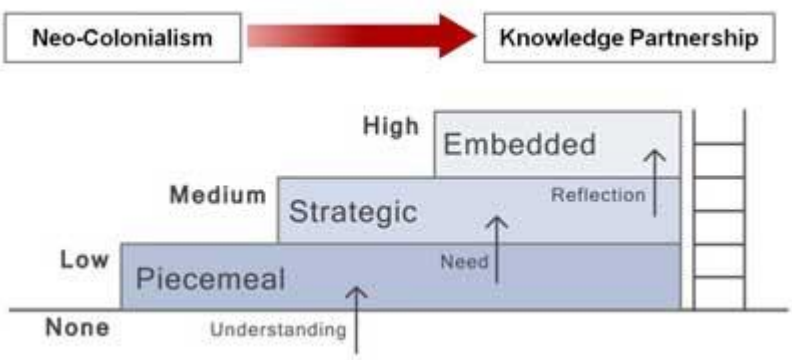

Figure 4: Localisation of Knowledge

Perryman, Hemmings-Buckler and Seal (2014) further this by identifying the factors they feel supported the OER project success and engagement in India (see image below) these factors may be influential in adaptation to the engagement experience of Playponics and worth consideration in plans for collaborative working and knowledge partnerships with localisers within India. Note that the last point of this image is 'openness and embedded engagement with OER', this could easily be transferred successfully to the concept of openness and embedded engagement of 'Playponics'.

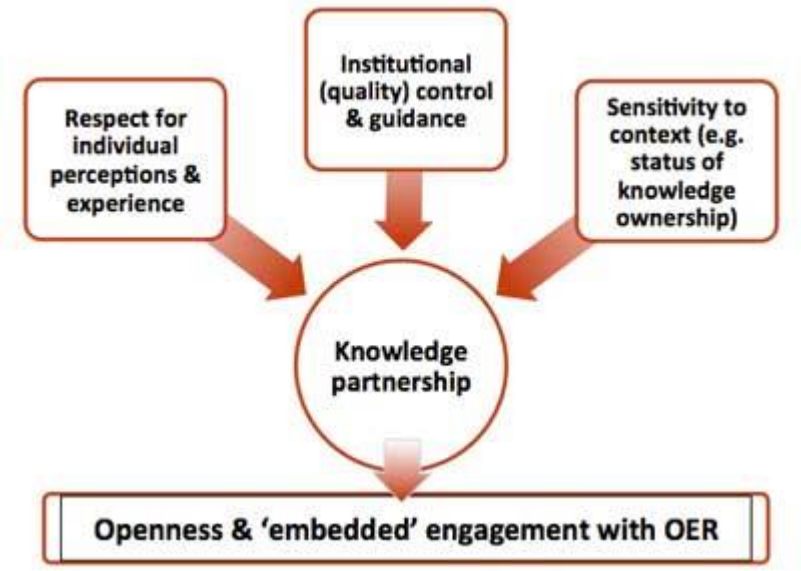

Figure 5: Factors which lead to success in localisation

When you consider these potential issues with embedding Playponics into a new school or culture, it becomes clear that a one directional flow of knowledge and resource creation should, in the long term, be avoided. Rather a collaborative approach (as highlighted above) should be considered as being embedded readily within the use of Playponics. This should enable a rich consideration of localisation needs and facilitate creation and use of shared knowledge. This partnership approach with communities/schools should prove mutually beneficial in the sharing of expertise and contextual understanding around how best the resource (Playponics systems and infrastructure) can be applied, allowing the resource to grow and develop iteratively and uniquely with each community

This should allow room for stakeholder ownership and eventual ownership of the embeddedness of the Playponics resource into the curriculum and upkeep of the Playponics resource and related teaching materials.

Potential Lesson Plan and Resources; An Example for Science Taken from the UK Curriculum

In order to provide a relevant example of teaching material which can, after suitable adaptation and localisation to the Indian curriculum and context, be used alongside and integrated to the use of Playponics systems and installations, a plant science teaching resource pack for the UK curriculum, has been included at the end of this report (see appendix 1) teaching materials are sourced from twinkle.co.uk. This resource pack is for key stage 1 (year 1, ages 5-7) of the UK curriculum, and includes lesson materials for Science (Plants: planting beans, year 1). These lesson materials serve as an example only, of materials that could be adopted, and then judiciously and appropriately adapted, for usage in STEM subjects, in an Indian context, as outlined in the above section on localisation. Consideration in adapting the materials should take care to include not just the change from bean plant life found in the UK, to the type of localised plant to be used within the hydroponics units specific to each school, state and environment, but also to available school resource. If a school is without electricity, for example, then printers are unlikely to be available for student handouts. Likewise, spare seeds/ beans to plant, may be difficult to obtain in large quantities in poorer institutions. Further issues to consider in adapting existing resources to an Indian context includes: having teachers qualified to support plant life experiments, appropriate language translation, ethnicities of images and staff willing to adapt and engage with new materials, etc.. All of these issues are to be considered in localising foreign teaching resources, but doing so will help the individual school or state to build a corpus of appropriate learning and teaching material for use with the Playponics equipment and systems they have installed.

Section 4: Recommendations for Playponics to Enhance the New Education Curriculum (2021)

Localisation Considerations and Co-production

Localisation can be defined as the “process of defining parts or components of the curriculum at community/local or school level, normally with the involvement of local staff, stakeholders and institutions, so as to address issues that are locally relevant and allow for more meaningful learning experiences” (UNESCO, 2021). Recognition of localisation is important to fully integrate the Playponics system into the school environment and become fully embedded as a resource within the curriculum, maximising student learning and staff usage.

Recommendation

Playponics educational adoption requires localisation consideration and co-production in the following areas:

- To address a particular teaching style or learning style
- To adapt for a different grade level
- To adapt for a different discipline

- To adjust for a different learning environment
- To address diversity needs
- To address a cultural preference
- To support a specific pedagogical need within the school
- To address either a school or a district's standardized curriculum (Perryman, Hemmings-Buckler and Seal, 2014)

This should be addressed in conjunction with the New Education policy (2020), National Curriculum (2005) and when released, the New Curriculum (2021), with sensitivity to the local schools' individual requirements, such as private or state funded, socioeconomic level and language needs. Consideration should be given to Playponics being piloted in different states within India and different types of localisation/procedures, processes, etc. as one size is unlikely to fit all.

Training should be provided on the aims and physical use of the Playponics system, with ongoing support from Playponics staff to an identified Playponics ambassador. The ambassador should ideally be someone who wants to support this resource within the school and can learn the practical skills needed to use the hydroponics system and cascade their learning to other local teaching staff as well as potentially co-produce. The ambassador's training should also be localised with language and cultural sensitivities recognised and adhered too, with training and support being time limited to ensure an end date is planned when full responsibility is handed over to the ambassador and educational administrative lead (e.g. a Head teacher or senior academic administrator).

The cascading of training from the ambassador would, aspirationally, lead to a team of trained educators in the use of the Playponics system, combining their education expertise with the hydroponics knowledge (stakeholder considerations will be addressed again further down). The ambassador, being ideally an educator, would be able to use the educational resources supplied with the unit to undertake localisation of the materials provided, adapting these to the individual needs of the school curriculum and pedagogy.

Latterly, when considering localisation and coproduction, investment (financial buy-in), resource and ownership of Playponics, lesson plans, etc., should be considered to avoid Playponics being initially adopted and engaged with only for interest to wain once the project with SHU ends.

Recommendations for the Enhancement of Education in India Through Playponics

Several areas of consideration need to be addressed for the integration of the Playponics system in schools within India; these include the following areas:

Stake holder considerations

Identification of stakeholders and their impact upon project usage and success, such as headteacher, curriculum head, class teacher, parents, governors, school children and business development partners or financers, should be considered to identify their aims, desired outcomes and involvement with the project.

Recommendation

Identification should be made of a key educational partner at both administration level within the school, e.g. a headteacher, and a member of staff to support management with school-based curriculum concerns regarding Playponics. Additionally, a key member of the teaching staff within the school who will be a Playponics ambassador should also be identified and selected. The

ambassador would ideally work with Playponics installation staff to understand the whole system, method resource, support the use of educational localised lesson plans to support other teachers using this resource and materials, with the aspiration that this would lead to teachers developing their own lesson plans to include the Playponics system within subject specific modules.

The administrative lead would encourage engagement amongst teaching staff to participate with the hydroponics unit and include where suitable Playponics into their lesson plans. Hierarchical understanding around knowledge and ownership and staff's potential reticence to adapt resources will be key to positive and successful stakeholder engagement (Perryman et all 2014).

School Current Pedagogy Versus Aspirational Playponics Friendly Pedagogy

India's education system heavily leans on the rote learning method to teach; this has connotations to British rule and while regularly used within the education system, does have its opponents due to is colonial past and its neglect of student-centred learning, along with other pedagogical learning methods (Sharma, 2020). Therefore, schools working with Playponics should be clear about their aspirational pedagogy and teaching methods as Playponics requires a student-centred kinaesthetic approach that can be melded with blended learning, combining both academic exploration and practical based activities to fully engage the learner and support learning fully. The new 2020 Indian Education Policy supports this change in direction of cultural educational shift within schools. However, to fulfil this, teaching staff need to be fully on board with these suggested changes to teaching practise.

Recommendations

Exploratory activities and co-production relationships around changes in pedagogical approach and suitable teaching methods specific to the school, cohort, state and educational governance policy should be explored so that teaching resources can be created to meet the localised needs. The following topics should be considered:

- Current teaching pedagogy and methods, along with aspirational pedagogies if needed, and if the school/teaching staff are motivated to engage with these
- Current learning theories applied within the school culture and aspirational ones to maximise Playponics engagement and learning experience
- Relationship to EE and how the individual school embeds this within their own school culture and curriculum
- How Playponics may be used individually to support STEM within the New national curriculum (2021), once published by the Indian government
- Monitoring and Evaluation (tools) of lessons/assessment suitable to generic lesson plans/assessment, including individualised briefs with consideration of how to adapt these to differing curriculum application due to differing school culture and state application and interpretation of central government guidance
- Creation by the Playponics team, or adaptation or adoption of existing monitoring/ evaluation of hydroponics project research outcomes within the school setting to identify outcomes such as perceived, intended and unintended outcomes of the project. The community toolbox offers freely available assessment and evaluation resources for community work and research. When viewing the community toolbox resources particular attention should be applied to the model for enhancing cultural competence (community toolbox 9) and/or evaluating the initiative community toolbox 12 evaluation for community program with a focus on example 1 which explores a model for evaluating a community

programme, giving step by step guidance see link https://ctb.ku.edu/en/toolkits and the research method of action research method available in most research books

This preliminary report requires further research and investigation to examine the minutia of the following points:

- Understanding of the educational application of the Playponics system in terms of pedagogical approach used in a pilot of Playponics installation e.g what is the school using currently and in what ways can that be adapted in collaboration with local teachers to incorporate Playponics in their long, medium and short term planning, curriculum , lesson plans and resources
- Analysis of appropriate methods to move away from rote learning that will be acceptable by teaching staff and mode of teacher training within India
- Additional exploration is also needed around educational assessment
- Long-term engagement of students and teachers to fully realise the potential for implementation and adhesion to the new national curriculum framework for schools due to be released in 2021.
- Example lesson plans and teaching resources to support all stages of curricula in selected subjects to support teacher engagement

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APPENDIX 1: Example Lesson Material to use with Playponics. Localisation needed for use Outside of the UK

Plants: Planting Beans

Aim:	Success Criteria:	Resources:
To identify and describe the basic structure of a variety of common flowering plants by planting a bean. I can describe how to plant a bean. To ask simple questions and recognise that they can be answered in different ways in the context of considering what plants need to grow. I can suggest a question about plants and a way we could answer it.	I can plant a bean. I can write instructions to describe how to plant a bean. I can say a question we could ask about plants. I can tell a way we could use our equipment to find out the answer.	Lesson Pack Mini whiteboards and pens - class set Beans - 1 per child plus extra Transparent cups - 1 per child plus extra Compost Small watering cans Sticky labels Lolly sticks
	Key/New Words: Bean, plant, water, grow, soil, sunlight.	**Preparation:** Differentiated Bean Plant Diary Activity Pack - 1 per child as required

Prior Learning: It will be helpful if the children have previous experience in generating ideas for experiments.

Learning Sequence

Asking Questions: Introduce children to the equipment they will be using in the session today. With a partner, children generate ideas for using the equipment. Model how to frame these ideas as questions to be asked, and record. In particular, draw out the following questions for investigation later in the lesson:

- What will happen if we don't put the bean in any soil?
- What will happen if we don't give the bean any water?
- What will happen if we leave the bean in the dark?

Planting Beans: On whiteboards, children write or draw what they think they will need to do to the bean to make it grow. Next, go through the instructions for planting a bean step by step, inviting individual children to give the next instruction, and other children to model the steps using the equipment.

Planting Beans: Children plant their own beans, water them and place them in a sunny spot. Ensure each pot is labelled with the child's name.

How to Plant a Bean: Using the Lesson Presentation, model filling in the How to Plant a Bean Activity Sheet in the Bean Plant Diary Activity Pack.

How To Plant a Bean: Using the How to Plant a Bean Activity Sheet in the Bean Plant Diary Activity Pack, children write or draw an equipment list and write a set of instructions for planting a bean. Over the next four weeks, find time to return to the bean plants weekly to measure their growth with a ruler and fill in the Bean Plant Diaries. The diaries will be completed in the final lesson of the unit.

Children use the Equipment and Instructions Activity Sheets in the Bean Plant Diary Activity Pack to draw an equipment list and sequence a set of instructions.

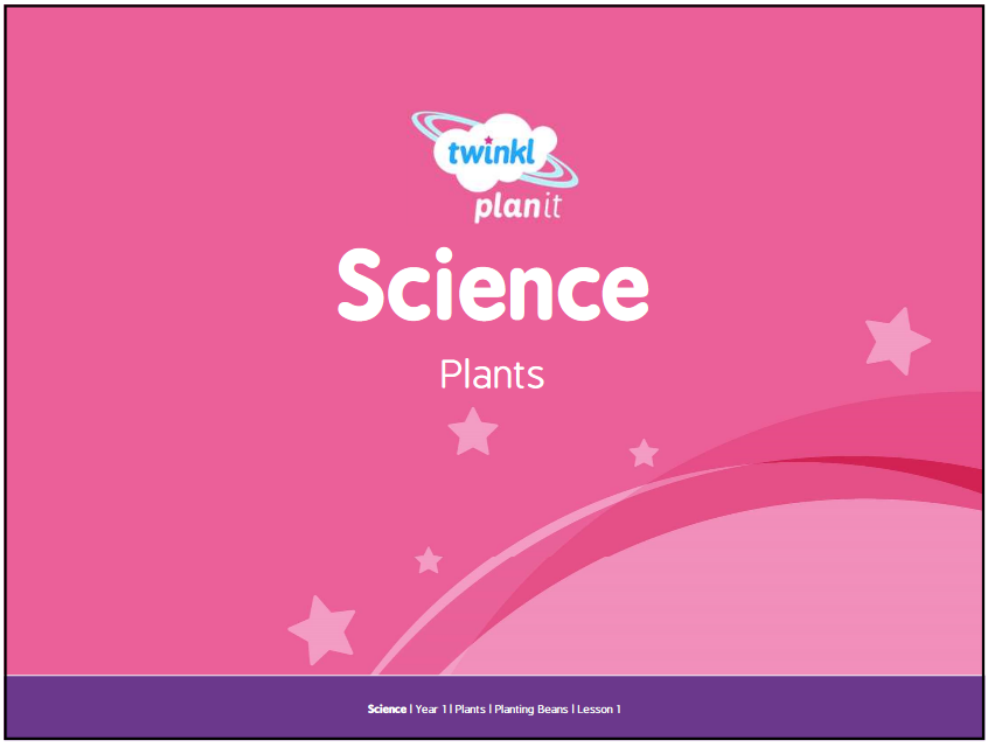
As an extension activity, children draw what they predict their bean plants will look like after 6 weeks of growth.

What Will Happen If...? Return to the questions generated by the children at the beginning of the lesson. In pairs, children discuss how to find an answer to the questions. Follow the Lesson Presentation to set up experimental beans to test these questions. If the children have generated interesting questions in addition to those featured, set up simple experiments to investigate these also.

Task*it*

Watch it: Watch this BBC clip for a simple explanation of the concept idea that plants are living things too.
Read it: 'Jasper's Beanstalk' by Nick Butterworth and Mick Inkpen is the perfect companion book to this activity.
Sing it: The 'I'm a Little Bean' Song is a fun and memorable way to reinforce learning about what plants need to grow.

Example Presentation:



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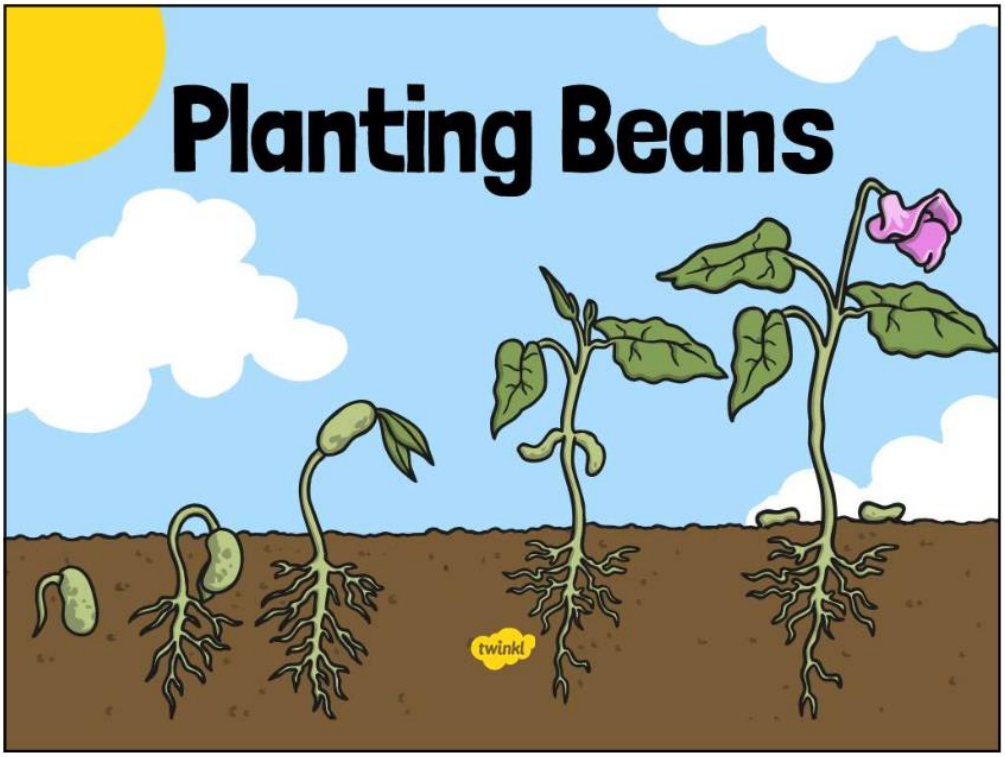

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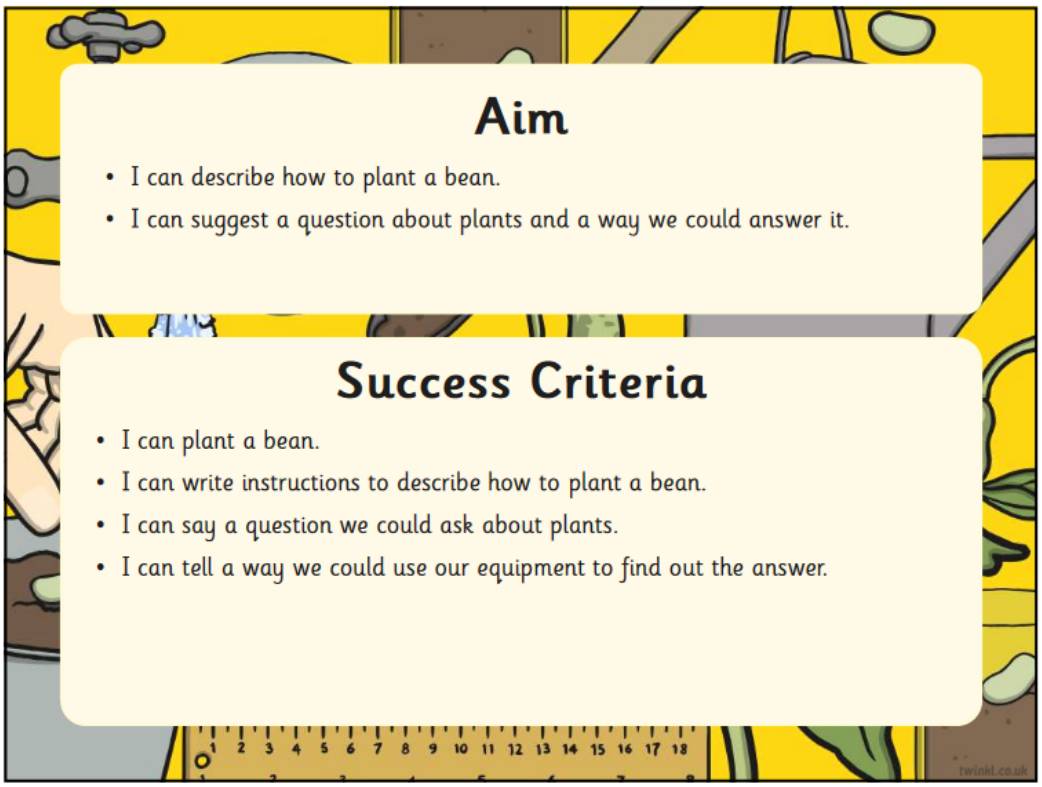
Aim
• I can describe how to plant a bean.
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• I can plant a bean.
• I can write instructions to describe how to plant a bean.
• I can say a question we could ask about plants.
• I can tell a way we could use our equipment to find out the answer.

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Asking Questions
In the class today we have some interesting equipment.
We have…
beans
watering cans
soil
pots

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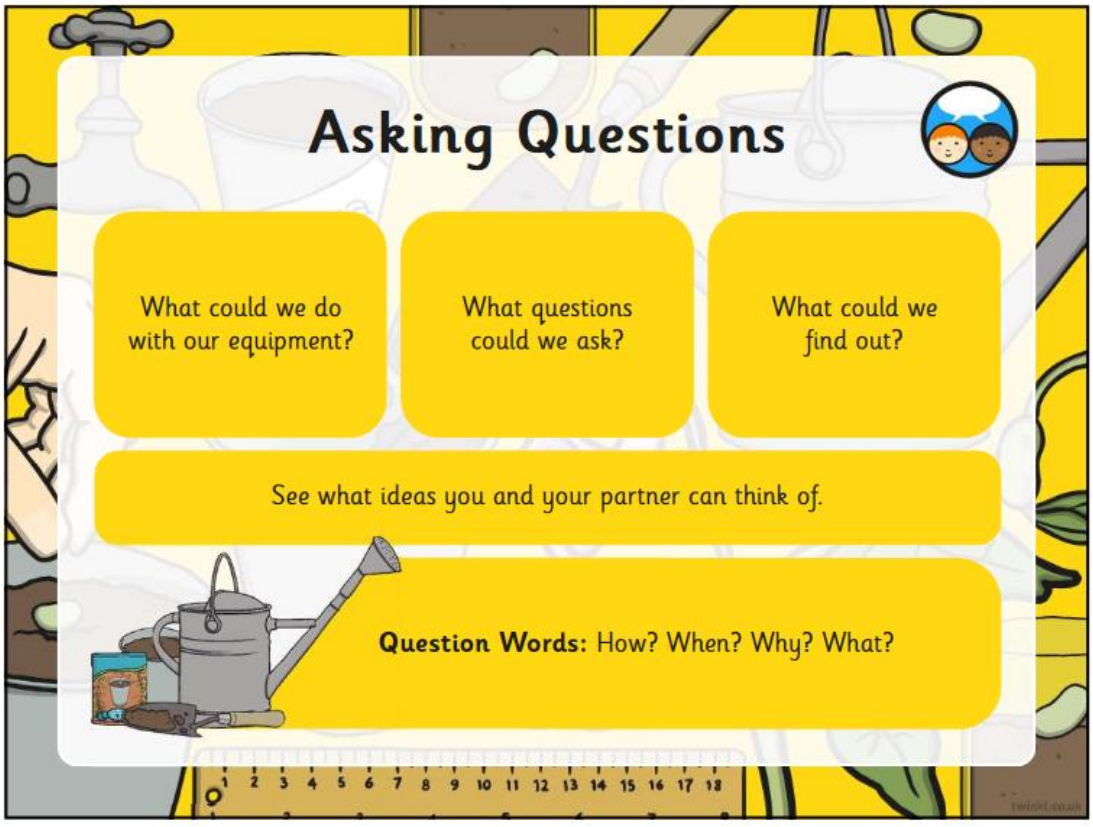
Asking Questions
What could we do with our equipment?
What questions could we ask?
What could we find out?
See what ideas you and your partner can think of.
Question Words: How? When? Why? What?

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Asking Questions
What questions could we ask?

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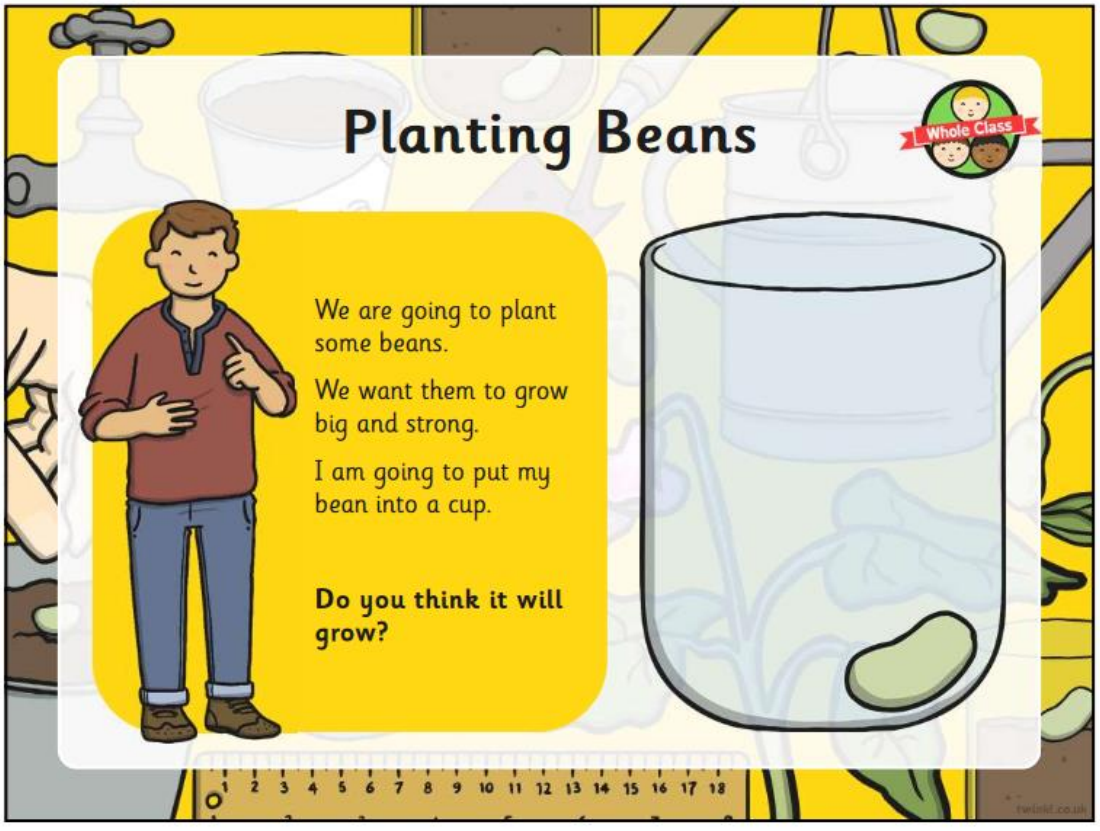
Planting Beans
Whole Class
We are going to plant some beans.
We want them to grow big and strong.
I am going to put my bean into a cup.
Do you think it will grow?

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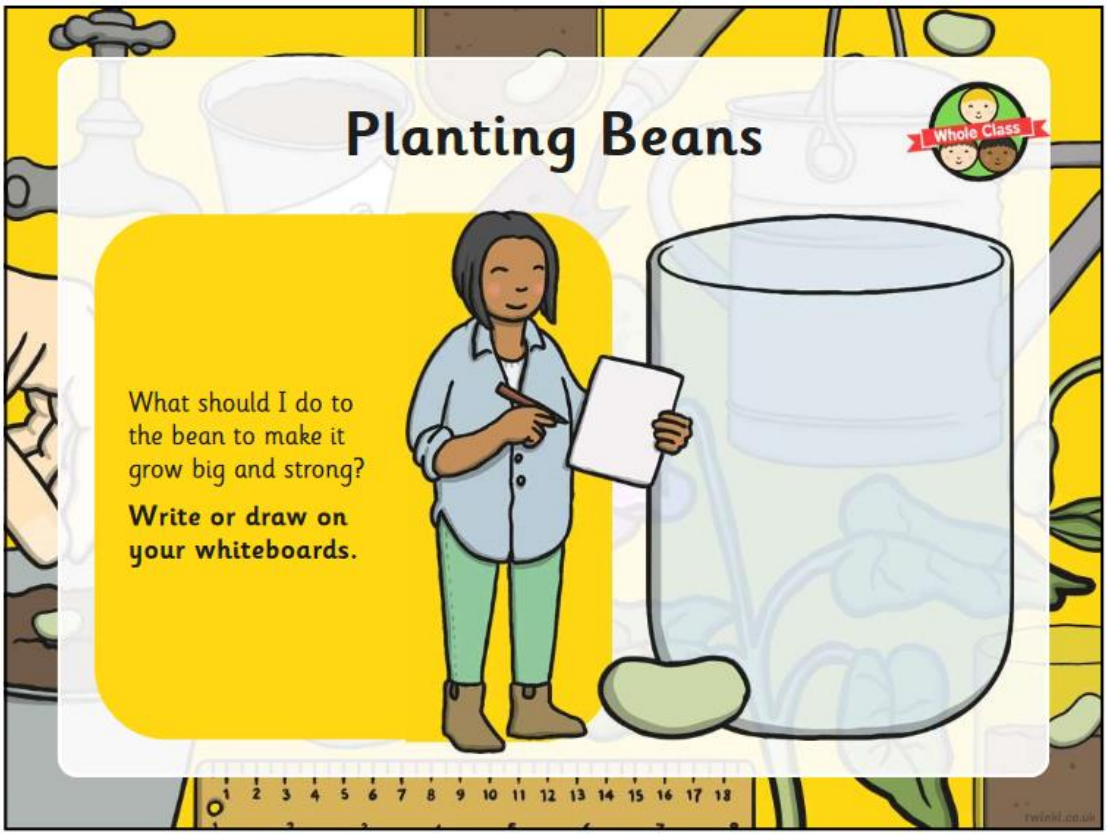
Planting Beans
Whole Class
What should I do to the bean to make it grow big and strong?
Write or draw on your whiteboards.

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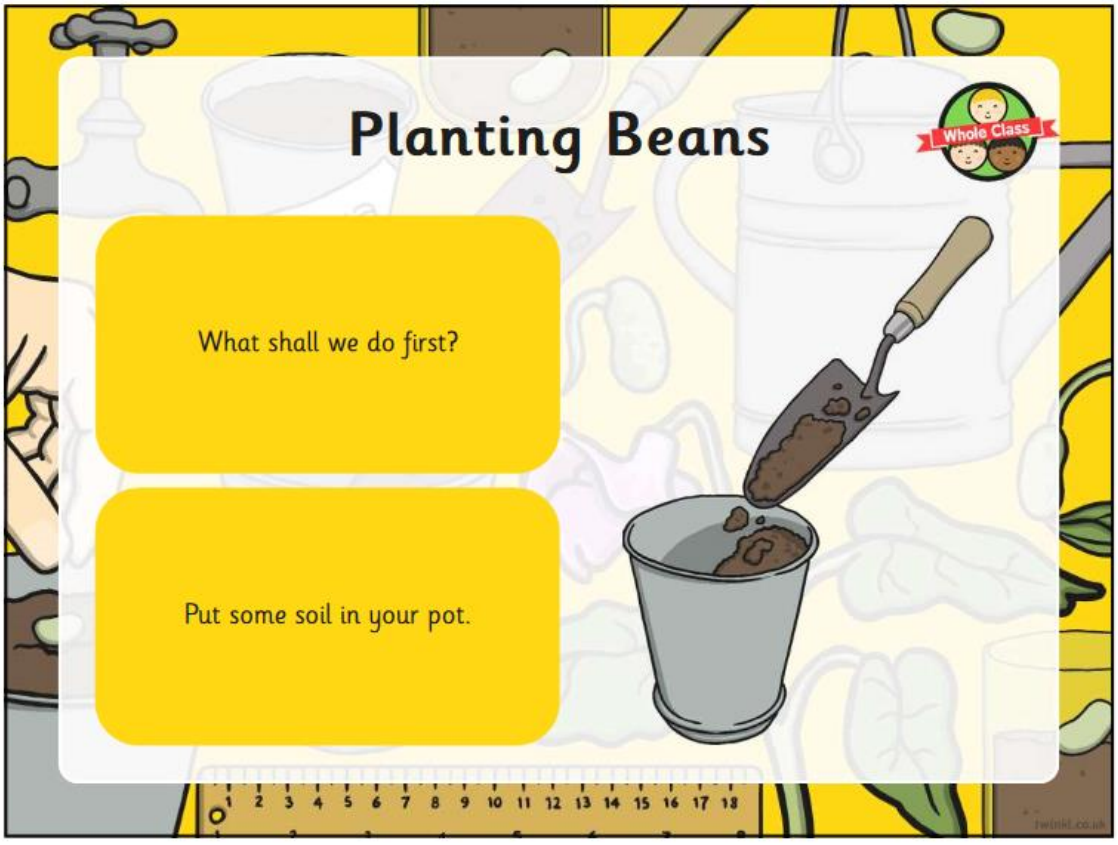
Planting Beans
Whole Class
What shall we do first?
Put some soil in your pot.

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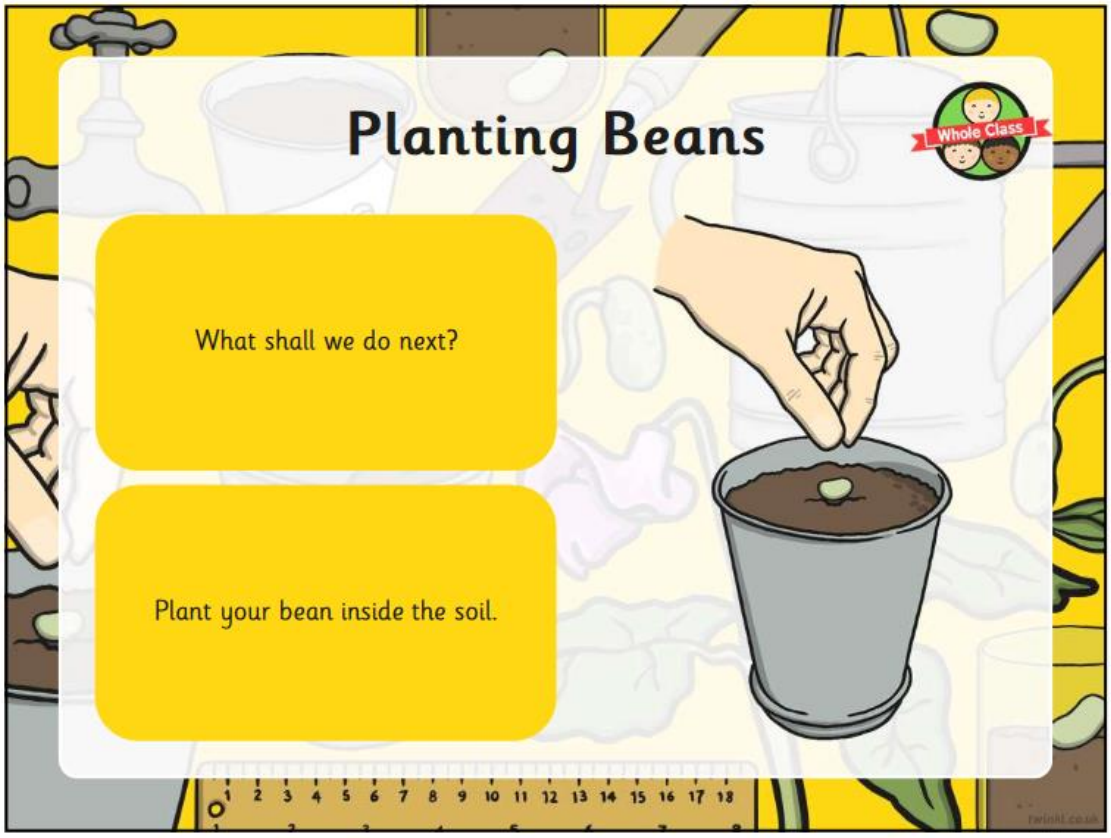
Planting Beans
Whole Class
What shall we do next?
Plant your bean inside the soil.

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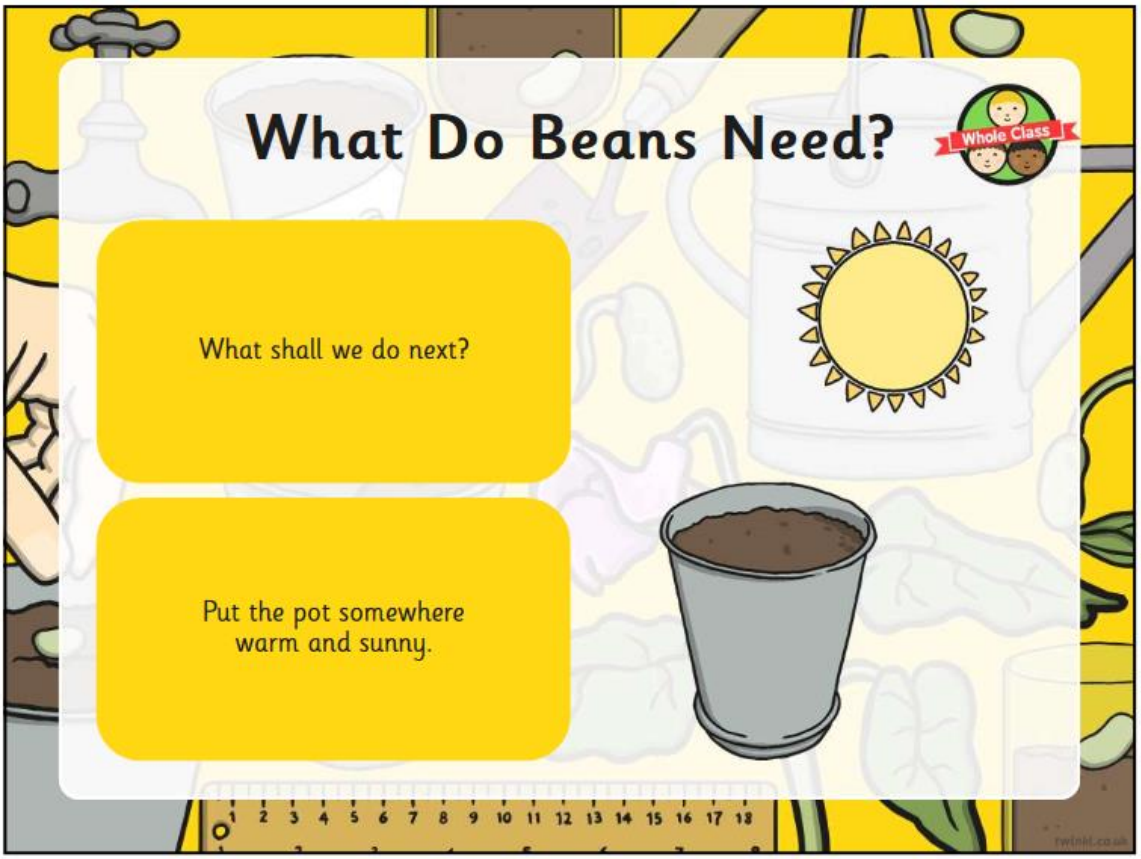
What Do Beans Need?
Whole Class
What shall we do now?
Give the bean some water.
Not too much!

12


What Do Beans Need?
Whole Class
What shall we do next?
Put the pot somewhere warm and sunny.

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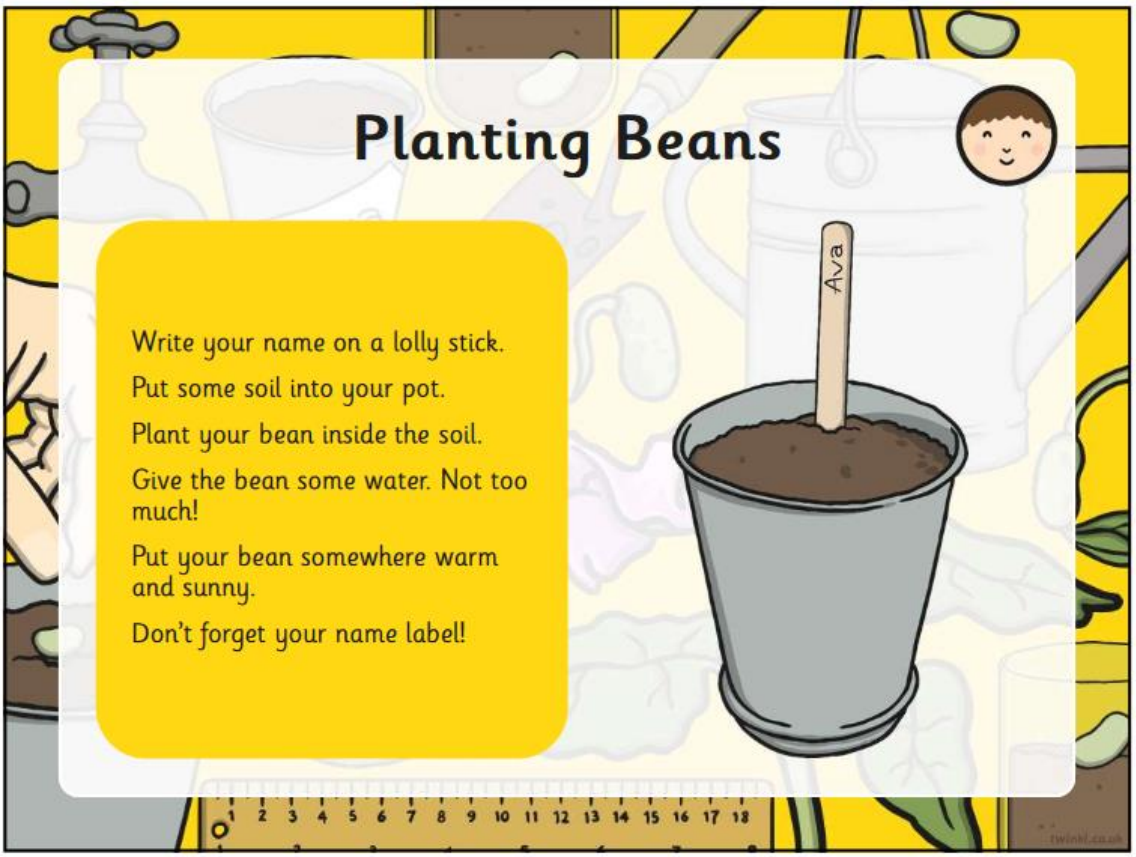
Planting Beans
Write your name on a lolly stick.
Put some soil into your pot.
Plant your bean inside the soil.
Give the bean some water. Not too much!
Put your bean somewhere warm and sunny.
Don't forget your name label!
Ava

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How to Plant a Bean
We are going to write a Bean Plant Diary.
Every week, we are going to look carefully at the beans and write down how they are growing.
At the end of six weeks, we can see how big they have grown and you can take them home!
My Diary of a Bean Plant
My Bean Plant: Week 1
My bean is ____ cm tall.

15


How to Plant a Bean
Equipment
What Do Plants Need?
Things Plants Need to Grow

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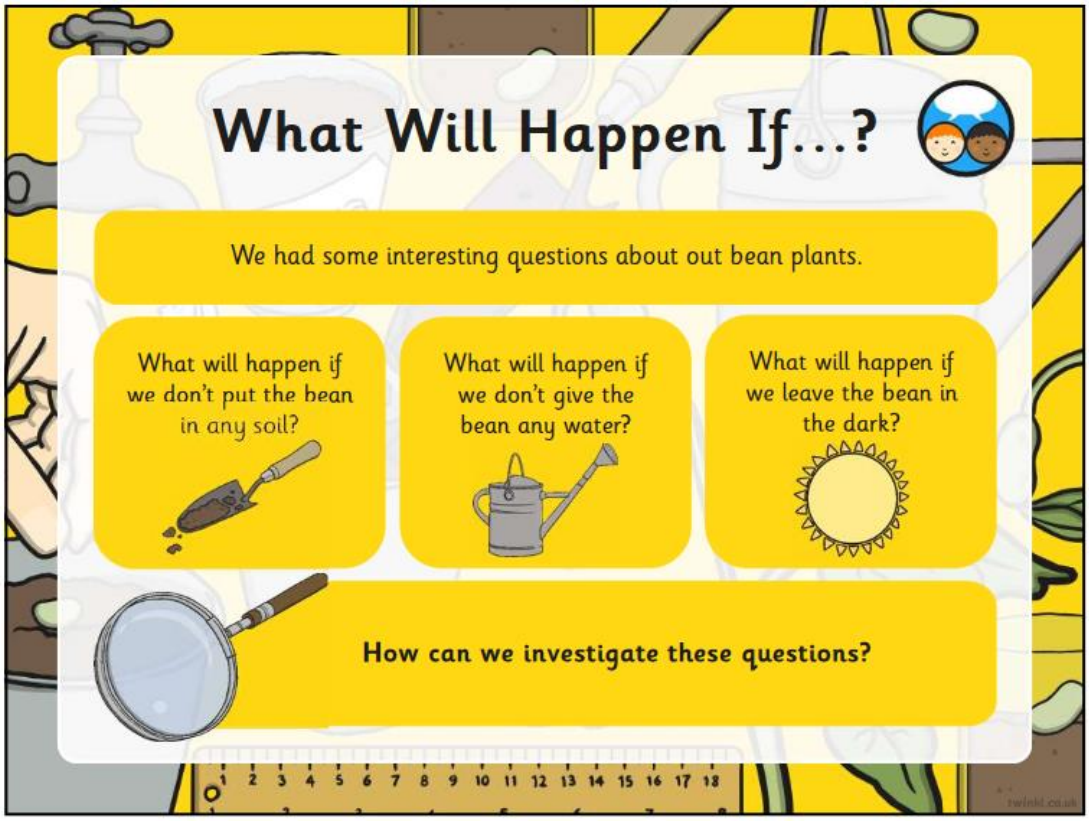
What Will Happen If...?
We had some interesting questions about out bean plants.
What will happen if we don't put the bean in any soil?
What will happen if we don't give the bean any water?
What will happen if we leave the bean in the dark?
How can we investigate these questions?

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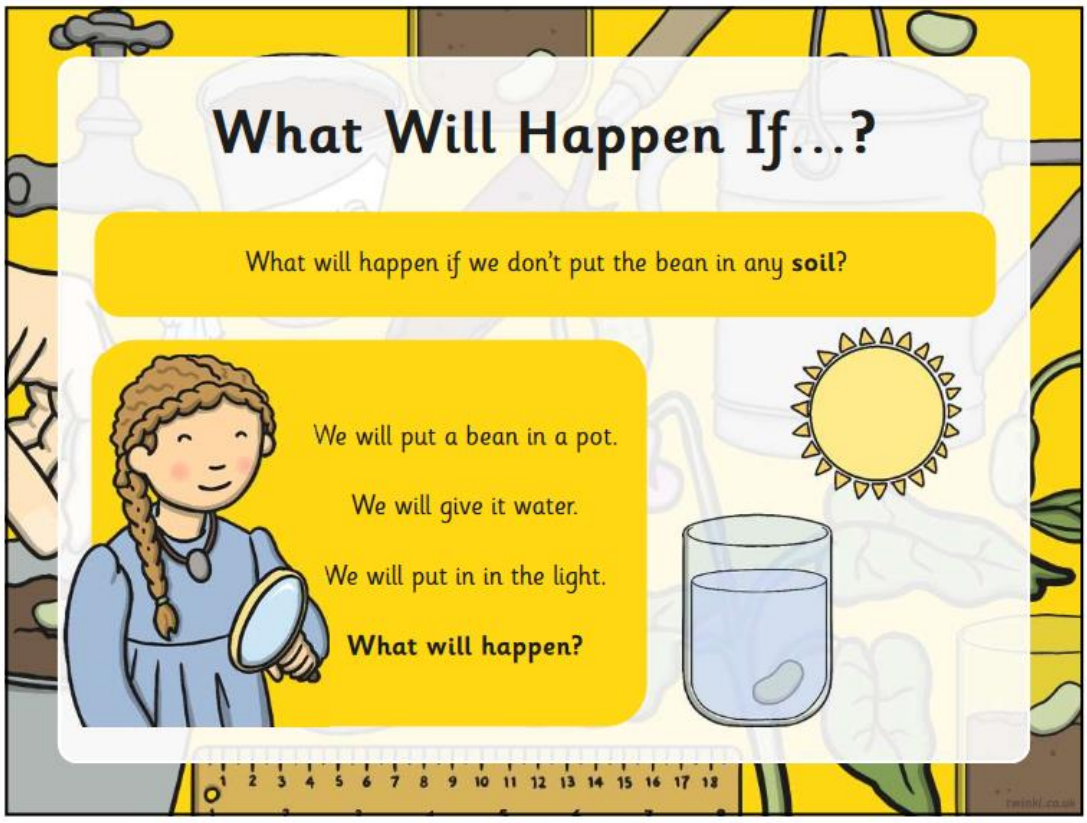
What Will Happen If...?
What will happen if we don't put the bean in any soil?
We will put a bean in a pot.
We will give it water.
We will put in in the light.
What will happen?

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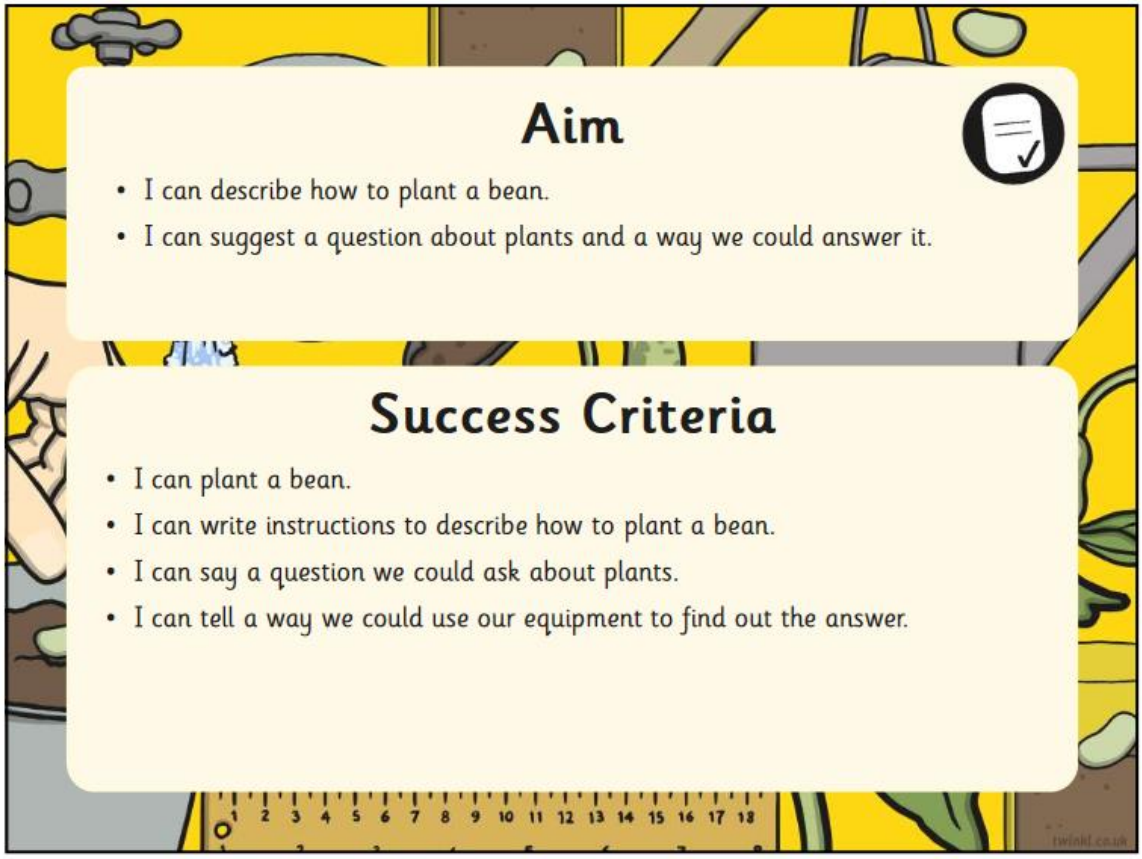
What Will Happen If...?
What will happen if we don't give the bean any **water**?
We will put a bean in a pot.
We will plant it in soil.
We will put in the light.
What will happen?

19


What Will Happen If...?
What will happen if we put the bean in the **dark**?
We will put a bean in a pot.
We will plant it in soil.
We will give it water.
What will happen?

20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