

**Blue-Green Farms of the Future:**  
Using Aquaponics at Primary Schools to Foster Sustainable Development.



Thursday 30,  
November 2017  
Collins Bosire

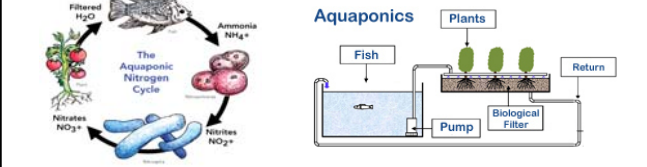
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- Drivers: why the research is needed.**
- Global food production problems- the concept of sustainable development and need for remedial action.
    - Focus in sustainable diets, WHO
    - Education for sustainability, UNESCO
  - Using technological approaches to mitigate some of the challenging aspects of the food system: food insecurity, climate change and food literacy.
    - A growing interest in experiential learning – the STEM principles: OECD
  - Agenda 21,-Education for sustainability much needed in our contemporary society: what can primary schools and school children do?

**Aquaponics: the basics**

In lay terminology:  
Aquaponics is a circular system in which plants and fish are grown together. "you feed the fish, the fish waste feeds the plants and the plants clean the water for the fish".

➤ To the knowledgeable: Aquaponics= Aquaculture+Hydroponics



- Conceptual foundations**
- Vygotsky's **Zone of Proximal Development (ZPD)** theory
  - Kolb's **Experiential Learning Theory (ELT)** model
  - Organization for Economic Co-operation and Development (OECD) **Knowledge Triangle (KT)** policy paradigm model

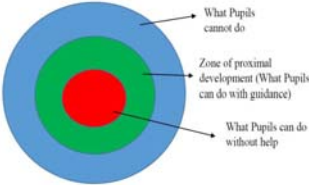
**Research Problem**

Can a low cost system be developed for teaching **Sustainable Development** and **STEM** in elementary school in a way that:

- is **feasible** for teachers?
- can create **learning insights** for kids?
- can enable **data collection** for mass experiments and continual improvement?

**Lev Vygotsky's Zone of Proximal Development (ZPD).**

*"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" (Vygotsky, 1978: 85).*



- ZPD developmental levels:
  - The actual developmental level (things that children can do on their own)
  - The zone of proximal development (the potential development)
- ZPD in practice (examples):
  - technical details on assembling a siphon bell.
  - detection of nutrient deficiencies.
  - plant leaf examination.
  - measuring and adjusting of the pH in the system.

### David Kolb's Experiential Learning Theory (ELT).



- Kolb sees learning as a social process supported by one's individual experiences.
- "experiential learning" and knowledge acquired is something human beings gain throughout life experiences.
- "experiential learning" underlines predominant role of experience as a major source of knowledge in the learning process.
- Children have a chance to learn by observation and direct interaction with an actual aquaponics environment.

### Educators voices on the challenges:

#### ➤ System maintenance:

"There could be problems in the summertime when the school is closed during vacations"

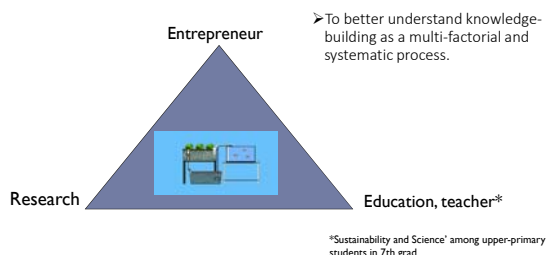
#### ➤ Insufficient knowledge:

"I don't know how much it takes to maintain and take care of the system"

#### ➤ Physical demands for attention:

"it can be a hustle to monitor the pH at all times and to have a constant input of fertilizer... but with the fish swimming, around, they contribute all the time with nutrients".

### Knowledge triangle at to work : concepts of research, education and innovation.



### Voices for STEM learning opportunities

- Learning subject specific (e.g. Physics) concepts.

"...the siphon bell introduces some things with gravity and so on"

- Visual clarity bridging the gap between the abstract/imagined state and concrete experiences.

"Here you will be able to see the roots shoot into the water which gives you a plant with nothing else but the root which is also good for the education part"

### Research findings – Some challenges

#### Entrepreneurs voice:

- **System cost:** "We need the two containers, at least two maybe three or four for the fish tank and the beds".  
"A pump that moves up the water and the bell siphon consisting of four-five different components are the two most expensive things"  
" it is mostly the feeding (fish) that has the cost"
- **System esthetics:** " ...it is nice to have it transparent so that you can see it"

### More opportunities ....

- Maybe used in exams according to standard curriculum.

"... The government has decided on, ... we need to teach the children about the nitrogen cycle. It is very important...maybe they can use it for their exams"

- Sharing produce beyond the school setting.

"...and if they make a lot of tomato, they would bring some of them home"

- A different way to learn for better understanding.

And especially because they can test what we are talking about and they can watch it and they can make their own evaluations"

## Even more opportunities...

- personal development: Educators can learn as well

*"I don't know very much about it, ... "am hoping that I will learn a lot from it as well. That's my main reason to do this."*

- Relevance and importance: putting theory into practise.

*"Because its biology...this is the thing with the fish and the plants and there is lots of biology and then the nutrients..."*

- Sense experience: e.g. To learn by experience by using different senses like tasting the products.

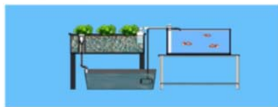
*"They (children) can touch it, and smell it and watch it and follow the process"*

## The budget

Materials	Cost (DKK)
• Fish Tanks/ materials for construction. <ul style="list-style-type: none"> <li>- 2x 200L and 4x 100L</li> </ul>	0 - school aquarium
• Pump Tanks/ materials for construction. <ul style="list-style-type: none"> <li>- 2x 200L and 4x 100L</li> </ul>	250
• Filtration/ water treating equipment. <ul style="list-style-type: none"> <li>- 2x 200L and 4x 100L</li> </ul>	250
• Automatic feeding equipment.	250
• Pumps to Grow Plants/ materials for construction. 2 x 200L <ul style="list-style-type: none"> <li>- 2x 200L</li> <li>- 4x 100L</li> </ul>	250
• Water Pump <ul style="list-style-type: none"> <li>- 200L</li> </ul>	800
• All Parts (hardware) <ul style="list-style-type: none"> <li>- 2x 200L and 4x 100L</li> </ul>	250
• Fish and Plants (initial costs) <ul style="list-style-type: none"> <li>- 2x 200L and 4x 100L</li> </ul>	300
• Irrigation Tubing (Pipes and fittings)	150
• Others - tools etc and misc.	150
<b>Total</b>	<b>2850</b>

## New system design and Implementation

The Design of the system



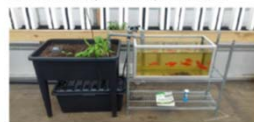
Dismantled for transportation



Actual system



How it will look like fully set with more plants to be added.



## Conclusion

- 375 Euro/unit
- Portable
- Fits well with the urban foodscape agenda
- Perceived as qualifying for STEM teaching
- Is considered meaning full for food & agri literacy teaching
- Impact assessment is needed



## What next ?

- System improvement through further innovation/automation.
  - Viktor- at IFS
  - Sustainable feed formulation for the fish.
- Collaboration with Cph-business: MVP for roll out to danish schools via municipalities.

*Thank you*