The Evolution of Finnish "Dream School" – Via Public Entrepreneurship from Innovative Concepts to National Scale-up

Pekka Leviäkangas, Allan Schneitz, and Aki Aapaoja

***Abstract*—Digitalization is changing our everyday lives and all sectors of human activities. The education system is amidst of this change. There is a growing demand for digital learning services and applications. Due to this underlying societal and technological change the education must be regarded as an ecosystem, where the different interacting organizations and individuals co-create applications and services. Forceful introduction of information and communication technologies (ICT) to schools and classrooms, while at the same time maintaining traditional processes and practices, creates a potential source of inefficiency, ineffectiveness and poor quality. Many schools and teachers complain that insufficient ICT equipment, such as interactive whiteboards and laptops, are major obstacles to effectively utilize ICT. This study presents a chronological development process of the Dream School -concept from Finland. The main purpose of the Dream School -project was to build an engaging and ubiquitous learning environment that utilizes a bottom-up approach to support students' growth and learning according to their needs - as well as according to identified societal future needs. The technologies exploited included open source code applications, open platforms, server -oriented and cloud -based ICT architectures. These technologies were developed and implemented in collaboration with private and public partners. This paper addresses three major aspects of innovation which define the nature of the Dream School –concept: 1) setting a vision for a future school, 2) building the ecosystem capable to deliver ICT services as a turnkey package; 3) innovative procurement. The impact of Dream School implementation on education system, decision makers and public-private partnerships is discussed.**

***Index Terms*—Education, innovation, ecosystem, school, procurement, ICT, service, open-source, scaling-up.**

I. Introduction

Digitalization is changing the world, our everyday lives and all aspects and sectors of human activities. Education system – how education is implemented, governed, and organized – is amidst of this change. The Digital Society has first changed how many businesses are carried out but a wave of changes is expected also within education system and how this system is interfacing other sectors and systems, e.g. health care, public management, and private sector in general. Furthermore, it is also changing many of the fundamentals of the economy and social networks. Absence of accessibility to the digital world means less knowledge, social exclusion, isolation and poorer quality of life – and in the end, less opportunities to make the best out of one's capabilities and skills [1]-[3] leading to an overall reduction in the competiveness of societies and individuals within them.

As education system is being renewed to digital era, several problems and challenges have been – and will be - on the way. These obstacles are highly contextual varying from rigid governance structures of the industrialized world to inadequate telecom infrastructures of the developing nations [4], [5]. Also, the digital society has proved to be faster in its evolution than what has been the ability of the education systems' to follow and fully exploit its potentials.

Finland has been recognized as a top notch country in basic education. Its PISA rankings reported by the OECD have been constantly among the best throughout the history of the ranking activity [6]. However, the higher level education rankings are not that flattering. The situation is somewhat contradictory. The contradiction is enhanced when we view the information society developments that were very high on the political agenda of Prime Minister Matti Vanhanen and there was a very ambitious strategy for 2007-2015 [7]. However, these goals were never fully achieved due to unfortunate domestic political incidents [8]. The education system, especially the primary and secondary levels (referred to as basic level from hereon), was not included particularly strong in this program, despite its obvious success in global ranking.

As global competition is enhanced, also regarding the education systems and as the global community and policy makers grow more aware of education system's importance as a competitive factor of any nation, the innovation aspects are immediately brought to the scenery. The recent OECD analysis on innovations in education from 19 countries [9] identifies several aspects of innovation, which were grouped in three main categories: 1) knowledge and method innovations, 2) product and service innovations, and 3) technology innovations. According to the report, education sector is more innovative than the administration sectors in general. Compared to other sectors, such as health care, education sector is not lagging behind, either. Furthermore, there are no clear patterns how different countries are ranked in the OECD's comparison. The top three countries, where innovation has taken place most at classroom and school levels are Denmark, Indonesia and Korea. Finland was not included in the survey. But in the authors' opinion the OECD survey challenges some of the stereotype perceptions on

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educational innovations and education sectors' conservatism – at least when compared to other public sub-sectors.

Education sector is not an isolated island. It contains certain ecosystems or it can be regarded as an ecosystem in itself. According to Moore [10], a business ecosystem is as an economic community supported by a foundation of interacting organizations and individuals. A business ecosystem includes customers, lead producers, competitors, and other stakeholders, e.g. governing bodies and regulators. The lead producers can be regarded as keystone producers, who have a strong impact on the co-evolutionary processes. In an ecosystem, the participants benefit from each other's participation through synergistic relationships [11]. Hence business ecosystems can be regarded similar to natural ecosystems which are robust, self-organizing and scalable architectures that can automatically solve complex and dynamic problems. It is noteworthy, that business ecosystems typically represent the supply side of the market. As they cannot survive without demand, the demand side of the market becomes a part of the ecosystem inherently (see e.g. [12]).

Due to the digitalization, there is a growing demand for e-learning services and applications and simultaneously many existing (business) ecosystems have become more digital-oriented as well. These latter mentioned are often referred to as digital business ecosystems. Within the ecosystem the different business models - relying largely on technological features and functionalities - will develop over time and adapt to changing environments. Like in nature's ecosystems, digital ecosystems include different kinds of layers. Briscoe and De Wilde [13] identify that digital ecosystems mainly work at two levels: service level and optimization level. At the first level, a wide spectrum of services, platforms or concepts are produced, offered and distributed in a decentralized peer-to-peer network. The first level feeds the optimization level which is based on evolutionary computing that operates locally on single peers and is aimed at finding solutions to satisfy locally relevant constraints. By separating the local optimization level from the service level, platforms or concepts are allowed to re-combine, evolve and expand their user base over time without too much interfering the local optimization [13], [14].

Digital ecosystems are mostly free, open source and distributed software platforms (e.g., cloud services). The European Union has stated that the main purpose of digital ecosystems is to enhance possibilities of small and medium-size enterprises (SMEs) to compete with larger software houses. By that the competitiveness of a region can be enhanced if the SMEs within it adopt digital business ecosystem early enough [14]. Working in digital ecosystems enables SMEs to integrate their current services with the existing and new business partners, through which it is possible to expand the current market area and share [11]. In sum, digital ecosystems can utilize existing product or service offerings, create new services and combine services with other services in order to create new offerings. Hence digital ecosystems provide unlimited access to use and create solutions that are designed to meet the specific needs of end-users and local demand.

Digitalization and emergence of new business ecosystems do not leave education sector untouched as has been witnessed. However, the change is more fundamental and well beyond ICT tools and e-learning apps. It is an obvious risk that forceful introduction of ICT tools to be adopted in schools and classrooms, while at the same time sticking in traditional processes and practices, creates a potential source of inefficiency, ineffectiveness and poor quality – plus in the worst case, frustration in persons who are encountering these risks. According to an EU survey, still many schools and teachers complain that insufficient ICT equipment, such as interactive whiteboards and laptops, are major obstacles to effective ICT utilization [15]. A study commissioned by the Finnish National Board of Education and carried out by VTT Technical Research Centre of Finland, however concludes that with more clever application and procurement of ICT significant cost savings and improvements in the quality of teacher work can be achieved [16]. Furthermore, the study identified some negative externalities that could be reduced. Digitalization enables new ecosystems to emerge also around schools and provides opportunities for more balanced public-private partnerships that will benefit for both sides.

II. Scope, Aims and Methods

This analysis is a single-case research of the innovations that took place for 2005 onwards until present in Kasavuori School in the city of Kauniainen, Finland. We present a chronological analysis of the steps that took Kasavuori School towards Dream School concept. The development path involves multiple innovations and we show that these innovations can be from certain viewpoints regarded as radical, whereas from other angles they can be considered just mere development activities. Two important aspects, which we regard as innovations or innovative steps, are addressed in particular. First, the digitalization of Dream School occurred in novel manner compared the usual practices followed in Finland. The procurement processes were renewed and more liberal practices established leading to procurement of ICT as a service rather than ICT hardware and software. Secondly, the build-up of the business ecosystem around the school allowed procurement of ICT as a service. Without innovative small- and medium-sized companies (SMEs) neither of the innovation steps would have been possible. Moreover, the steps would have been unachievable had not the technological maturity been in place. The emerging of second level digital business ecosystem provides a clear reference point, relying on first level enablers. Dream School ecosystem provided a scalable second level optimization built on the first level (service level) platform.

The impacts of the innovations are assessed and some prior studies are revisited where some of these innovations were actually quantitatively measured. These measurements provide implications for methodological approaches in the assessment of impacts of innovations that have taken place or pursued. We will discuss the measurement problems in the discussion part of this paper as well address the challenges of scaling-up (from one school towards national adoption) and recommend strategies and measures which have proven to be successful for Dream School.

As our empirical material is restricted to one single case,

the generalization must be done with cautiousness. However, the scale-up that has been witnessed in Finland – throughout the country, from south tip to the very north as well as from small schools to larger ones – will in our opinion prove that particularly these incremental innovation cases are actually the way towards systemic innovations. Also these aspects are discussed more in depth in the end part of this paper. We in fact claim that inductive approaches are the ones that work best when contexts are mature and hence also somewhat inflexible due to long-established processes and institutional structures and settings, but this may not necessarily be so in other contexts.

Finally, we shall summarize Dream School story and present our interpretation how this story was contributing to policies and strategies of national level actors and decision makers. However, these are not the only relevant actors. A business ecosystem that was built around Dream School is described using descriptive methods, such as Customer Value Chain Analysis (see e.g. [17]). The build-up of this ecosystem was essential as we shall show in this paper and while at the same time we underline the education sector as a critical block in public services repertoire, the prospects of liberalizing parts of the service processes are shown as they seem yield to a socio-economically profitable outcomes. We shall demonstrate this with the help of basic cost-benefit calculus.

Our paper on Finnish Dream School highlights the evolution story of the emergence and evolvement of the ecosystem around it. The story also observes how the school became a part of and tackled (as well as became a part of) the trend of digitalization. The results of Dream School practices, processes and technological solutions as well as the national scale-up are a convincing observation how innovations and innovative approaches can bring true value both to the society and businesses when renewing an entire basic education sector.

III. The Finnish Dream School Story

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A. Laying the Foundation 2005-2008

Schools have always supposed to be the centers from which new ideas spread to the surrounding community. However, changes in society, such as the development of information and communications technology, have showed schools to lag behind from the rest of the society. In City of Kauniainen this phenomenon was recognized with utmost seriousness.

A development effort was initiated by the local School Board after a strong recommendation coming from bottom-up, i.e. from Kasavuori School to renew the local education system and meet the demands of basic education that would prepare pupils for the changing world. The goal of the Future Process (or Future Program) was to give the necessary tools for all pupils [18]. To reach this goal, the widening gap between the digital reality in home and school was one of the critical issues that needed to be bridged.

Learning and instruction was surveyed from the future needs point of view: what skills and information will the adult of the future need? In the working life of the future the ability to work meaningfully, productively and competitively requires continuous maintaining and developing know-how, in other words lifelong learning. The mobility of skilled workers will increase. The need for special experts and multi-skilled persons will increase. The know-how of the future will also be collective competence. The importance of networking and interaction skills will increase. Media skills are significant in surviving in ubiquitous society. In the more complicated world the importance of the skills to control one's life will increase. Most important five tasks/goals of the future teacher and learning as follows:

1) To consolidate knowledge- and skill-related abilities
2) To awaken general ability and desire to learn
3) To consolidate creative passion
4) To consolidate enriching interaction
5) To consolidate the individual's self-confidence.

Several practical actions and steps took place in Kasavuori School. During the school year 2005-2006 the teachers were arranged four lectures concerning the future. The school was visited by a renowned philosopher Dr. Pekka Himanen, distinguished visionaries like Mr. Jyrki J. Kasvi, a member of Parliament, and Mr. Tapani Ruokanen, the chief editor of *Suomen Kuvalehti* magazine (one of the most prestigious in Finland), and Dr. Erno Lehtinen, the professor of pedagogics from Turku University. A more analytical work was carried out in the form of SWOT-analyses to define the present situation of Kasavuori and Mäntymäki schools (the associated secondary level school). The views of Kauniainen's top officials and elected council members concerning the future of basic education were taken in a joint meeting with the future process work group in January 2006. The status of basic education now and in the future was dealt with on the basis of the outlines made by the mayor, Mr. Torsten Widén, Mr. Finn Berg, the chairman of the city council and council member Mr. Pekka Koskinen. An outreach towards parents was made and workshops and surveys were organized to map parents' expectations regarding the school.

The role of School Board (consisting of parents, pupils and teachers) in the guiding of Future Process was enhanced. The work group and the board had four common seminars, and cooperation has continued ever since. Even a vision and strategy for Future Process was devised. The Future Process results were issued in Spring 2009. But, it was only after this ground laying work when the practical steps were taken that lead to Dream School as a concept.

B. First Innovation Step – Liberalizing the Procurement System for ICT (2006-2007)

In Finland, municipalities and cities govern the schools as well as the procurement processes of ICT, which are then implemented in schools. The recent Finnish national plan for ICT in education defines the strategies, policies and proposed measures for the educational use of ICT. There is still much room for improvement in the deployment and use of ICT [19]. According to the national plan valid at the time [20] (year 2010), ICT procurement should be carried out as a comprehensive process involving both users and service providers. The national plan further sets priority targets for the use of ICT in schools. The recommendation of the

National Board of Education from 2005 set detailed targets for workstation density etc., in other words concentrating pretty much on technical details that one could measure as a signal of adoption of ICT. For service levels there were (and still are) few if any targets. It has been recognized (also in this study) that the targets tell only indirectly about the efficiency, service level and utilization rate of ICT in schools.

Prior to 2007, the ICT services used in schools were supplied by the City of Kauniainen's own information management unit. The unit was in charge of workstation procurement, installation and disposal; maintenance of workstations and applications installed on them; maintenance and development of internal school networks and the fiber network connecting city offices; and maintenance of the server environment for school networks. The city's budget included the costs of annual computer and ICT appropriations for individual schools, and it was used to pay for, among other things, new servers, workstations and network equipment, as well as for spare parts for existing equipment. The budget for the schools' computer and IT appropriations was also used to pay for operating system and software package expenses as part of the price of workstations with which the systems and packages had been ordered.

There was a general discontent concerning the ICT services and hardware received by the schools. According to interviews in Kauniainen [16] (but also elsewhere), the teachers and rectors felt that their needs were not met and that the equipment and services provided were based more on other facts than on their stated preferences. In plain words, the school staff felt that the information management unit of the city of Kauniainen was making the procurement decisions and dictating the functional specifications without listening to them.

In 2007, basic education provided in Kasavuori and Mäntyvuori Schools in Kauniainen underwent a process change in which the procurement of ICT equipment and services was transferred from the information management unit to the schools. The main difference compared with the traditional model was the schools' strong role in defining their own needs and planning procurement. A school-specific ICT-team presented its proposals to the steering group of the Finnish- speaking school administration, which then decided on procurement and development including coordination and harmonization of needs. Service and equipment expenses were from thereon paid directly from the schools' own assets.

The new model incorporated a server-oriented architecture where the majority of the applications used by both students and teachers were positioned on LTSP-server (Linux terminal server project) and quite many applications were renewed based on open source codes. Key roles in this change were played by the school and selected service providers who collaboratively designed a new architecture that minimized the operating costs and extended the life time of workstations. In this Linux operating environment the processing was shifted from workstations to the server, hence relaxing the workstation performance requirements [21]. Open source applications were further developed by several service providers.

The server and network-oriented architecture adopted in autumn 2007 differed considerably from the previous solution in which applications launched by users were run on workstations which in addition had to be maintained one-by-one. Essentially, the new deployment made more efficient use of old equipment stock which did not have to have substantial processing capacity and centralized the maintenance operations making them far more efficient.

C. Building the PPP Ecosystem around the School (2007–2011)

The above described new ICT architecture and shifting of the procurement model from hardware and software oriented specifications to service-oriented procurement based on users' needs called for several new types of service providers for the school who had the understanding of school's core needs and who could design their business models accordingly. The previous centralized municipality controlled model relied on established ICT and software providers and larger hardware manufacturers plus on their own user support operating models. These business models were mainly based on licensing. However, in the "new world of order" the school needed several service providers in its supply network whose business cases were service-based – these providers did exist at the time, but schools were not necessarily their primary business segment and they were not working as an ecosystem or network towards the schools.

First, there needed to be a service provider making sure that the servers and connected workstations were running reliably and that the processing capacity fulfilled the needs to the education processes. For example, the start-up time of former workstations tended to be tediously long stealing valuable teaching and learning time of the staff and pupils. Times long as 15 minutes were recorded occasionally. This resulted in frustration and down-time. The server-oriented architecture reduced radically the start-up times, down to less than one minute, and lessons were carried out with less effort consumed with non-functional ICT. Moreover, the entire wired and wireless communications infrastructure was likewise procured as a service which had to be interoperable with the municipality's existing network. This resulted in more reliable connectivity to the internet.

Secondly, reliable connectivity enabled novel innovative learning and teaching apps became more easily available as app developers were allowed to offer their products freely via the server, provided that these apps were accepted by the teaching staff. In fact, Kasavuori School was the first school in the country to offer this type of offering platform for app developers.

Finally, new educational e-concepts and services found for the first time a direct connection with the users through Dream School architecture. Until then, the providers of these were tied by administrational processes as they were offering their materials via National Board of Education and municipal school administrations. Now, a new channel for their products existed and perhaps most importantly, a show case for promising materials and products was offered by Dream School.

Fig.1 shows a simplified Customer Value Chain Analysis of the initial Dream School concept. There are different value propositions coming from market actors that must be combined into feasible and usable services. This is why the service providers (SP) are in a crucial role: they combine

other value propositions, such as infrastructures and hardware as well as some contents into service bundles that better meet customers' expectations. In the education sector, the customers are in the end after societal impacts, but the societal value creation is not realized unless at operational level the users (i.e. the teachers and students) receive services that match their needs and ability to make the best use of the services.

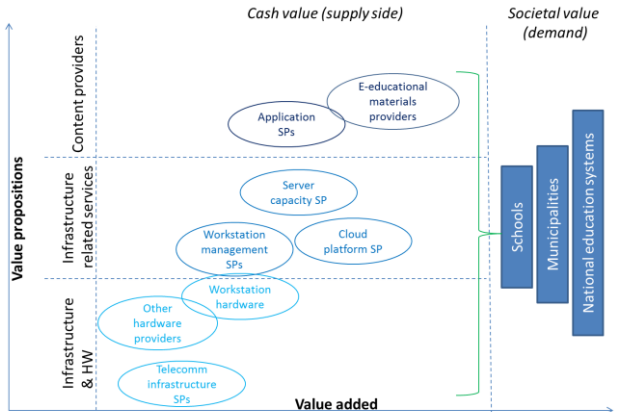

Fig. 1. The initial Dream School ecosystem in the provision of ICT.

D. Impact Evaluation – Proving the New Procurement Model Works (2010–2012)

By this time, a national interest was raised towards more efficient utilization of ICT in schools. Also the experiences gained in Kauniainen were observed widely. As part of larger research program initiated by education sector and resourced by the Finnish Funding Agency for Innovation, VTT Technical Research Centre was contacted by Dream School staff. VTT was asked to perform an analysis on the benefits of the Dream School concept. The analysis was specifically focused on the procurement model of ICT and how the new model had affected ICT utilization, costs and user satisfaction. The results of the analysis were reported in 2011 [22] showing noteworthy improvements in many respects.

According to the evaluation report, due to the new architecture solution and service-level definitions by users, service quality was significantly improved, unit costs per workstation were reduced by about 40% and, because of extended life cycle of workstations and reduced electricity consumption, the environmental load was cut by about 50%. These impacts came from the technological solutions, not from the contractual arrangements per se, but the key point is that new types of service contract definitions allowed new technological choices to be made.

Fig. 2 shows the results of the cost analysis. The unit costs per workstation reduced significantly, the number of workstations per student was increased while the unit cost per student was kept almost constant, though not entirely. Combining these results with the facts that user experience reports were consistently on the positive side, the proof-of-concept started to look very convincing. It goes without saying that VTT's results provided the first science-based evidence that the concept and modus operandi worked well.

E. Scaling-up: Open Source Code Released (2013)

Dream School's service providers' open architecture extends the use of workstations by several years. Individual workstation life time could be approximately doubled. The server –oriented architecture was very quickly advanced into cloud services, and cloud technologies have until today been the core technological platform for Dream School ICT. Also all applications and services are today almost exclusively based on open source web-based services, and most of the school's ICT budget is spent on services and use of creative open source tools instead of license fees.

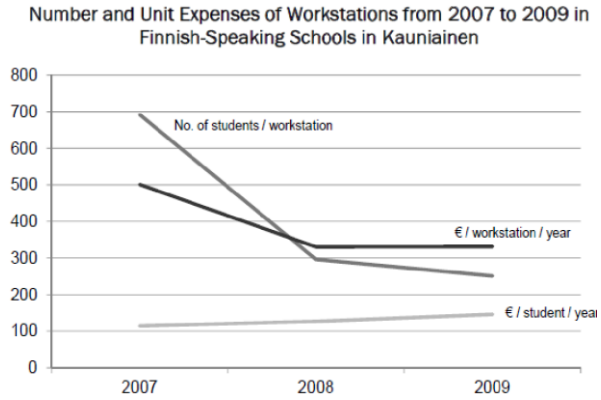

Fig. 2. Results of the cost analysis [16].

From the technical solutions Dream School has now moved on to design and development of services that are without exception based on user needs, good functionality and easy access through a single sign in. Dream School has through a decade of hard work reached a fortunate position where their ICT reputation attracts partners eager to build tools in collaboration with the school. These partners include high-level administrations, such as National Board of Education and Ministry of Culture and Education, as well as high-caliber private companies.

The Dream School platform combines various normally isolated communication solutions (e-mail, electronic student services, learning platforms, chat rooms, etc.) to one single interface. It is possible to connect services from different companies and actors to the platform since it rests on open source technology and open APIs and interfaces. Platform is published under BSD (Berkeley Software Distribution) modified license. This allows all users, from both supply and demand side, to develop the code after their own interests. It also facilitates more straightforward agreements on general IPR issues, which are usually problematic with new types of e-business models. The publication of the codes removed many of the existing "vendor-locks" and allowed de facto limitless scaling-up of the platform concept for all schools, throughout administrations, and all vendors and service providers of the country – or in the world for that matter.

F. National Roll-out – Market-Driven Scale-up (2013-)

Dream School was scaled-up nation-wide because of two reasons. First, the public sector – namely National Board of Education and Ministry of Culture and Education – endorsed the concept and were committed to support scale-up through financing pilot projects. Second, the release of the open source code and evidence provided on the proof-of-concept created demand to which the business ecosystem (supply side) was able to answer due to their own capacity building through Dream School "exercise". The business ecosystem also

foresaw that the education market was about to open now, after successful pioneering and piloting.

The above required also some re-shaping of roles of both private and public sector. Some key actors' rethinking was necessary. To start with, the National Board of Education that works as a central agency under the ministry was responsible for the national curriculum design and development of the education sector as whole. Dream School provided them a good example how ICT and paradigms regarding the schools' role in learning should be changed now to meet the challenges of tomorrow. The Board was first of all strongly involved in many projects of Dream School, and for some efforts (the evaluation study) additional funding was granted by Funding Agency for Innovation (Tekes). The present role of the Board has been declining, though, whereas the Ministry has taken more active role especially regarding national roll-out. However, this roll-out does not necessarily have the Dream School label on it, but is merely a part of national strategy implementation for which Dream School seemed to offer a good example approach.

Ministry of Culture and Education has since beginning of 2014 taken a stronger grip on Dream School concept scale-up. The scale-up is embodied in several programs associated with the concept. Below two most extensive ones are referred to:

Palveluväylä (based on X-road project; see e.g. http://www.x-road.eu/about.html) is a national effort to digitalize public services. The model is applied from Estonia, and Dream School concept fits into this effort seamlessly. The Ministry of Finance coordinates Palveluväylä.

Pilviväylä is module of Palveluväylä that is dedicated to education sector. The idea is to provide e-learning contents and services to basic education schools across the country as cloud-based services; the model is identical to Dream School but again, the label is not used as such.

Both of the administrational keystone actors were supporting projects carried out in different parts of the country where Dream School ideas were piloted and tested further. The objective of these projects is naturally to verify Dream School's concept more widely. Altogether about 30 schools are deploying projects, financed primarily by the Ministry of Culture and Education. Many of the impact assessments and evaluations are non-technical in nature, i.e. focusing on student well-being, teacher empowerment, and social networks within schools. A much wider population of schools have taken independent steps and utilize Dream School platform, but not necessarily under the same label, as explained below.

Ecosystem companies, who represent the supply side, have been active in the scale-up too. The most important of these is *Tiera Ltd*., which was established in 2010 as a joint venture of Finnish municipalities. The business idea of the company is provide joint and interoperable ICT solutions for the entire shareholder base that consists of more than 200 municipalities. Tiera adopted Dream School's business and operating model and now offers their own tailored platform, *Edison*. The platform is built on Dream open source code. Today, Edison platform has about 50 000 users. The first tier business ecosystem firms, meaning the companies that were building Dream platform, have their own clients. Exact number of users remains a business secret, but most likely it is around 20 000 (our own estimate). Dream platform users yield to ca. 10 000. There are also other brand names relying on Dream platform.

IV. The Innovation Path Line and Cost-Benefit Analysis

Looking at the history and evolution path of Dream School, we can link the chronological steps – as identified in previous chapter – and user volumes of Dream School and identical Dream-originated platforms. This is visualized in Figure 3.

It is noteworthy that each of the steps we regard as essential towards the national scale-up. First, there had to be a sense of need to improve state-of-the-art. Second, there was a careful consideration what these needs are, but not necessarily exhaustively yet being able to list them. However, the awareness needed to be adequate in order to take concrete action. Recognizing digitalization as one of the trends to be tackled, the focus started from school and education related ICT and identifying paradigm shift from teaching to learning. Having cleared these at conceptual level, the procurement of ICT was changed so that learning (as well as teaching) needs were met in a manner that answered the grand challenges as well as improved everyday working conditions. This in turn was facilitated by a number of market actors who were ready and able to provide solutions. Without the supply capacity and capabilities of the supply side ecosystem, the change would not have taken place.

The scale-up was dependent on two critical phases. The first was the results from VTT study proving that the new approach and concept yielded to tangible benefits. Without the proofs, the justification would have stayed at the level of subjective perceptions, which can be shot down with erudite arguments. And finally, the release of the source code broke the dams, as is observed from the exploded number of users.

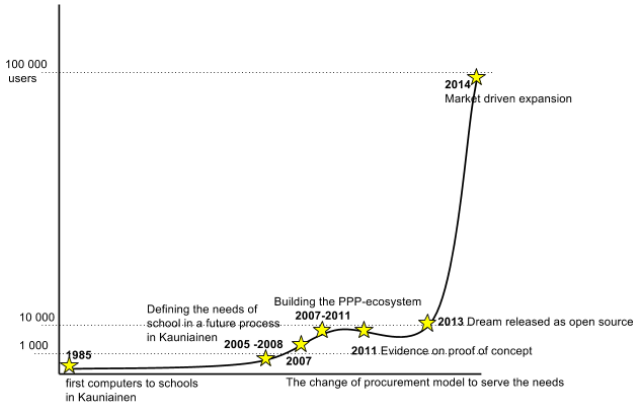

Fig. 3. Innovation path-line towards scale-up.

One of the issues that still remain somewhat open is the benefit-cost spill-overs of Dream School concept. Exact figures are most likely hard to find, but a rough conceptual model can easily be constructed. In this benefit-cost assessment we take the entire ecosystem view plus the national level implications which takes us closer to macro-level impacts. We shall identify the following cost/benefit components: capital expenditures (CAPEX), operating expenditures (OPEX) and externalities (EXT). Benefit can be a saving in cost (CAPEX or OPEX or EXT).

Externalities are items such as environmental costs, i.e. items that touch the entire society and not directly any ecosystem actor. In this category we also include items that have a more qualitative or quality based impact rather than direct monetary flow. For example, improved efficiency of teaching classes has no direct cash or monetary impact, but is still relevant thinking of productivity of the work of pupils and teachers.

Table I depicts the tentative business cases for each actor. It should be noted that clear business cases were not there in the very early stages of Dream School. Instead, these were developed and shaped as experiences were gained.

TABLE I: COST-BENEFIT ASSESSMENT FRAMEWORK ("+" INDICATES BENEFIT, "-" A COST)

Ecosystem actor	Dream School pilot			National scale-up
	CAPEX	OPEX	EXT	CAPEX / OPEX / EXT
School(s)	+ duplication of the life time of work-stations	procuring services	+ improved efficiency of classes	+ working efficiency improvements, 150 M€ p.a.
Cities and municipal	+ 100 k€ annual savings p.a.; this equals to 12 € p.a. per citizen			
State (and society)	na	na	+ 50% decrease in carbon footprint	
Service providers	- investments in ICT	+ increased sales	na	
Hardware suppliers	decreased sales	na	na	

V. DISCUSSION AND CONCLUSION

Dream School was quite successful concept but from the very start to actual national and demand-driven scale-up several years of hard work and dedication was required. To sum up the lessons learned, which at this stage need to be considered as tentative hypotheses based on observations on Dream School evolution, we present the following postulates (P):

P1: Any change or incremental innovation answers to a more or less clearly recognized need or challenge

For Dream School, this was the sense of need to meet the increasing demands for education, which can be with good reason to categorize as the "grand challenges" of which we are globally aware. Digitalization, need to increase global competitiveness and perhaps most importantly, the need to find paths towards sustainable and meaningful life. That is why the Future Process was initiated in Kauniainen in the first place after regarding development and improvement as a holistic, integrated process, not merely as an introduction of various technologies and isolated solutions.

P2: To make the change, an ideology or value base has to provide a solid foundation for striving towards the set goals

Dream School was not really about ICT or procurement models. It was a concept that sought sustaining solutions to realize the concepts and ideas the school had. Many things could have gone (and went) wrong along the way, but the idea sustained and kept the process on-going. A shared ideological foundation makes the progress more resilient against back-steps that will be faced on the way of any true innovation.

P3: Ideology or value base is followed by three critical prerequisites in order to pursue innovation or ideal: will, skill and manoeuver space

Ideals must be back by strong will and necessary skills in order to be realized. But likewise there needs to be the room to make manoeuvers that are called for and seen necessary. In Dream School case the will was strengthened through Future Process collaboration throughout the municipal administration and luckily, and without any predetermined planning, the skills just happened to be within the school as well as in the market supply ecosystem that was gradually built around the school. The manoeuver space was created by letting the school to make its own procurement strategies for ICT, hence allowing innovative market actors to take a decisive role in the development of the school's ICT infrastructure. This happened through a close collaboration with school staff. Also the school was allowed to build its own value base and make an exceptional outreach towards parents. A substantial amount of individual entrepreneurship was required from the school staff as well as from market actors.

P4: The time must be right for innovation and systemic change

For Dream School all pieces fitted together in timing sense: the state programs on information society, the municipal Future Process, the readiness of the market actors to step in and have service offerings that matched the needs. If the effort would have been made a decade, or even perhaps five years earlier, the outcome could have easily been less successful.

P5: There must be an ecosystem that covers both public and private sides as well as supporting functionalities of demand, supply and regulation

The Dream School concept required the support from the administration in addition to entrepreneurship in the public side. Furthermore, there must be a strong vision of goals and targets to point the actions approximately to correct direction. The supplier side, i.e. the private sector actors must have adequate and complementary skills and tools in their offering. Without their capabilities the innovation efforts may remain a quite typical "public development project" with more superficial action and less true substance. All in all, the capabilities throughout the ecosystem must broadly match the overall objectives and measures that are performed on a way towards them. The business cases for private side players must be there too – and this is an important notation. Without tangible cash flow logic in sight the business side will not

make a move.

For Dream School the inclusion and commitment of innovative SMEs was decisive. It seemed to be the case that smaller companies with "equal" negotiation power compared to that of an individual school were ready and willing to enter a tighter-than-usual partnership. It is noteworthy, though not surprising, that some larger companies became interested in the concept inly after demonstrated impacts and benefits, and especially when the national scale-up started to be within vicinity.

The innovation model that is witnessed in our case can be classified as fifth generation model [23] which is characterized by definitions such as systems integration, extensive networking, flexible and customized response and continuous innovation. The continuous development from idea to transferrable and scalable tools and applications shows that innovative concepts are often a mixture of different types of actions, taken by different actors on a time scale, making it hard to pin-point one particular criteria or milestone that makes innovation to succeed or fail. Hence it is good news to those who believe innovations are less manageable than many "innovation managers" think. And vice versa, this might be bad news for "innovation managers".

Dream School also presents many different types of innovations in one package, and therefore we consider it as a systemic innovation. First, there was a process innovation how the school began to interact with its environment. Second, new business and operating models were deployed, especially around school's ICT systems. Finally, the process that lead to the scale-up was ingenious, but note, not entirely conscious: from ideas the school went to radical changes in its modus operandi, but it at the same time made the effort to harness researchers to validate their efforts. The latter mentioned is something that is rarely witnessed. Furthermore, the school's networking with business ecosystems, administration, research community and other schools was far beyond the usual.

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