Pedagogical Outlines for OLPC Initiatives: A Case of Ukombozi School in Tanzania

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***Abstract*—One-to-one computing initiatives in developing countries have been criticized for ignoring pedagogical considerations and for lacking tight integration with the local educational context. Ukombozi primary school in Iringa, Tanzania, faced the same situation in 2009, when we received 100 laptop computers for pupils to use. Through a collaborative effort of local and foreign teachers we designed and tested a pedagogical approach which starts from the local educational context, and builds on theoretical literature and documented experiences of using one-to-one computing in the classroom. We developed student-centered, exploratory, and creative practices for classroom pedagogy, and we experimented on using individual (one-to-one) laptops as a support tool. We identified a number of challenges, too, and propose further research directions that extend one-to-one computer-assisted learning to other school subjects, also. This paper is aimed at educators who work and develop education in similar challenging environments, as well as educational technology researchers who wish to gain alternative views about pedagogical design.**

I. Introduction

One-to-one (1:1) computing has lately gained notable media attention, as well as the attention of academic researchers [1], [2]. *One-to-one computing* refers to the idea of equipping every student with a personal computer (usually a laptop, handheld, or tablet computer), access to Internet, and various kinds of software for educational purposes [3]. Often one-to-one computing initiatives are marketed as a part of a wider educational reform, such as a shift towards self-directed, project-based, problem-based, collaborative, intrinsically motivating, or creativity-supporting approach to learning [4]. Educational 1:1 computing initiatives started from the industrialized countries, but during the past decade one-to-one computing has increasingly been proposed as a solution to educational problems in developing countries, too [1].

Despite the increased interest in one-to-one computing initiatives in developing countries, little academic research has been published on the topic [5], [6, p.110]. Plenty of criticism, however, has been presented towards the existing one-to-one initiatives in developing countries—and mostly that critique is aimed at the One Laptop Per Child (OLPC) Foundation's project (e.g., [6], [7]). Kraemer et al. [8] wrote that "expecting a laptop to cause such revolutionary change showed a degree of naïveté, even for an organization with the best intentions and smartest people". The critics say that computers in classrooms have not worked in the industrialized countries either [9], so it would be excessively optimistic to believe that they would "reform" education in developing countries. In fact, the OLPC Foundation's central statement "It's an education project, not a laptop project" is in direct contrast with the OLPC Foundation's focus on laptop development and with their open disregard of content development and pedagogical development [3].

Along with some massive roll-outs, such as Uruguay's Plan Ceibal, OLPC Foundation has supported a number of smaller pilot projects in various countries. In July 2009, Ukombozi primary school in Iringa, Tanzania, received 100 children's laptops from the OLPC Foundation. Those laptops have been used in a number of children's workshops [10], but aside from some classroom experiments, one-to-one computing is not used to support classroom teaching in regular classes at Ukombozi. Most of the time the laptops remain unused. We agree with the critics of the OLPC project that the main reasons for the poor integration of computers into the curriculum are, firstly, the lack of teacher training, and secondly, the lack of practical guidelines for integrating computers in classes.

Although there is little research on one-to-one computing in developing countries, there is plenty of experience on similar initiatives in industrialized countries. That experience, however, may not be directly applicable in Tanzania's unique developing country context. Hence, in our research, which lasted five months, and which consisted of two workshop sessions per week, we aimed at finding out what happens at the class when class periods are designed to utilize 1:1 computing and modern constructivist pedagogy. The target group of 7th-grade learners was dominantly computer illiterate, and they were used to an instructivist mode of teaching.

This paper presents results from an education research experiment at a rural Tanzanian primary school between November 2010–March 2011. Our analysis suggests a number of ways for bringing student-centered, explorative, and creative learning practices into the classroom. Our analysis also suggests that one-to-one computing played a positive role in supporting those learning practices. In our experiment, the learning outcomes, pupils' working styles, and the tangible

outputs of the worksop were impressive, which warrants for extending research towards further integration of one-to-one computing in the classroom.

Chapter II sketches a brief overview of one-to-one computing in western education. Chapter III presents the theoretical background of constructivist pedagogy as well as some of its applications. Chapter IV presents our methodology, research questions, and methods of data analysis. Chapter V presents our results, and Chapter VI analyzes and discusses the implications of our results, and suggests directions for further research.

II. One-to-One Computing

Soon after the birth of modern computing, educators started to consider ways of using computers for fostering education. Before the 1960s, however, most computers were batch-processing mainframe computers, usually with very limited input and output functions. In the 1960s time-sharing systems and new programming languages—especially BASIC—sparked a small number of computer initiatives in schools, but only in the late 1960s serious attempts to use computers in primary and secondary education emerged. Especially remarkable initiatives were Alan Kay's Dynabook and Seymour Papert's Logo programming language.

Around the mid-1970s personal computers started to slowly be introduced in schools, and educational program industry started to develop. Yet, it was only after multimedia and laptops started to mature in the early 1990s, when 1:1 computing started off as a serious, practicable, and scalable idea. At that time a number of pioneers, including Seymour Papert and Alan Kay, proposed the idea of equipping students with laptop computers [11]. In the mid-1990s experiments in 1:1 computing included, for example, Microsoft's and Toshiba's Anytime-Anywhere-Learning program (earlier Learning with Laptops program) in the United States [12].

But although there were a good number of positive reports on one-to-one computing in schools, the "no significant difference phenomenon" [13], which applies to most delivery modes of education, seemed to apply to laptop initiatives in schools. The "no significant difference phenomenon" refers to a meta-analysis of hundreds of research studies, in which researchers compared the results of a distance education course to the results of the same course in a face-to-face format. In a vast majority of those research studies [13], researchers found no significant difference in learning results between distance education and face-to-face education, mutatis mutandis.

For one-to-one computing the "no significant difference phenomenon" means two things: In one-to-one computing mode of education, one should not expect *better* learning results than in face-to-face education—yet one might not expect *worse* learning results, either. It is, however, myopic to consider only those improvements that can be measured right away. A recent meta-analysis [14], which analyzed forty years of research on the impact of technology to learning, showed a significant, positive, small-to-moderate effect favoring the utilization of technology over technology-free face-to-face instruction. That study also found that the average effect was higher in K-12 classrooms than it was in postsecondary classrooms [14]. Hence, in those cases where educational technology research suggests no significant difference, there are grounds to consider whether a *different pedagogical approach* with the same technology might have shown significant results.

Yet, improving immediately measurable results is not always the gist of one-to-one initiatives anyway. Instead, many one-to-one computing initiatives aim at providing educational possibilities where there are none, making up-to-date material available, delivering expert lectures over distance, rationalizing assignment and grading procedures, transforming pedagogy or classroom dynamics, centralizing educational resources, freeing learners and facilitators from temporal and geographic obstacles (anytime-anywhere learning), substituting expensive laboratory equipment with simulations, activating otherwise unmotivated students, offering adaptive learning experiences for students with varying preferences, or learning a completely new set of skills, such as problem-solving skills, IT literacy, or "21st Century skills" [3]. These aspects of education can have a major transformational effect to all learning, but that effect might not be easily measurable right away.

In today's one-to-one computing initiatives the characteristics of equipment range from small and cheap PDAs to various kinds of laptops and multi-user desktops. Because in developing regions cost-effectiveness is an especially important issue, the focus in one-to-one computing initiatives in developing countries has been on relatively cheap and simple computers [1]. Attempts at providing affordable computers to developing countries include the late 1990s' Simputer project, the OLPC XO-1, and Intel Classmate [1]. The push towards fixing the educational problems of developing countries using low-cost one-to-one computing gained momentum in the mid-2000s, when the One Laptop Per Child Foundation was founded [15]. Soon after the introduction of the XO-1 computer, Intel Classmate and Asus Eee PC, which introduced the "netbook" form factor, were introduced [1].

However, bringing netbook prices and sizes down is just one aspect of increasing computer use in education. New tools require new pedagogical approaches too, and those tools support new kinds of learning styles. Of all the critique surrounding the OLPC Foundation's project, the critique that we find to be the most serious is the accusation that contrary to its mission statement, the OLPC Foundation's project is not an educational project but a laptop project. One critic wrote, "the OLPC education philosophy does not address the education system at all [...] There is no consideration of how this intervention fits or does not fit with the current curriculum, assessment, or pedagogical practices" [16]. Another wrote, "If OLPC were indeed an education project then it would proceed from the basis of an analysis as to what is wrong with education in the developing world and how it could be fixed" [17]. A third one claimed that the OLPC project's pedagogic model is seriously flawed, its real educational value has not been sufficiently proven, the cost of roll-out would be prohibitively high, and the same amount of money could be

better spent on teacher training [6, pp.110–111].

Now, as technical developers have taken a head start over other kinds of development efforts that are needed for successfully improving one-to-one computing in developing countries, it is high time for educators to speed up development of pedagogical models for one-to-one computing in education, too. In the following section we outline the process through which we built our pedagogical approach, and we elucidate the theoretical underpinnings of our approach.

III. Theoretical Background

It is argued that the mainstream teaching and learning models in Tanzania as well as many other developing countries involve instructivist, directed teaching, which may result in rote-memorizing learning strategies and extrinsic motivational orientations of students [18]. It is also argued that in Tanzania and in other developing countries too, there is a lack of experimenting, demonstrating, and problem-based teaching and learning.

There is, however, ample evidence of positive learning outcomes from pedagogical-technological interventions. A project in Florida, involving more than 50 K-12 schools, reported increase in student-centred, collaborative, and project-based learning practices by utilizing laptop computers [4]. Another meta-analysis showed that technology had a significant positive effect on learning outcomes, especially in K-12 classrooms [14]. In that meta-analysis, each of the successful educational technology projects had utilized their own, unique pedagogical bricolage, adjusted to the local context.

Learning from the successful pedagogical-technical interventions, we designed a pedagogical approach, which utilized the trigger effect of new technology in the classroom, and which relied on modern pedagogical ideas contextualized to the reality of Tanzanian rural primary school. In this section we describe the pedagogical aspects that we combined together.

A. Supporting Intrinsic Motivation

Intrinsic motivation refers to a state of motivation, where an activity is performed primarily for its own sake, because the activity is perceived as interesting, satisfying, involving, and challenging. Extrinsic motivation, conversely, is defined as a motivation to perform activity primarily in order to meet a goal extrinsic to the work, such as attaining a reward, passing an exam, or getting recognition [19], [20]. Niemiec and Ryan [21] argued that people's innately curious and inquisitive nature should be harnessed by educators. Yet, educators often introduce external controls and close supervision to ensure learning [21]. Under such conditions feelings of joy and interest in learning risk being replaced by anxiety, boredom, and alienation [21]. Such conditions create an atmosphere where students are not interested in what is taught, and teachers must externally control students to make learning occur.

Intrinsic motivation is typically perceived as a favorable condition per se, and it is often linked with improved learning outcomes, deep-level learning, and enhanced creativity [22]. Conversely, extrinsic motivation is linked with instructivist teaching and surface-level learning strategies. Niemiec and Ryan [21] evaluated elementary school teachers' reports of their orientations toward supporting students' autonomy versus controlling their behavior. Results showed that those children who were assigned to autonomy-supporting teachers (compared to controlling teachers) reported increased intrinsic motivation, perceived competence, and self-esteem over time [21]. Intrinsic motivation can be supported in a classroom through its three components: supporting learners' autonomy, their competence, and their feelings of relatedness [21].

Due to the positive reports in literature on supporting intrinsic motivation, we adopted a locally contextualized approach to strengthening intrinsic motivation. Our approach is described in Section V.

B. Constructionism and Constructivism

In the form described by Seymour Papert [23], constructionism as a pedagogical theory follows Jean Piaget's constructivism, which is based on the premise that we construct our own perspectives of the world through individual experiences. The main idea behind constructionism is to activate students into experiments on the subject matter instead of passively receiving information from the teacher. Papert defined constructionist learning as reconstruction rather than transmission of knowledge [23]. Constructionism is frequently connected with technology-related educational interventions, such as LOGO programming language and LEGO Mindstorms. At the early stages of the OLPC project, Seymour Papert worked with the OLPC project team, and constructionism was employed as the pedagogical keyword for the OLPC project. However, the OLPC foundation never expounded on *how* to combine XO-1 computers and constructionism into educational practice.

For practical guidelines in supporting constructivist learning, we used a constructivist theory of teaching and learning called the *cognitive flexibility theory* [24], which presents several guidelines for supporting constructivist instruction. The cognitive flexibility theory stresses that one should avoid oversimplification of instruction, provide multiple representations of content, and emphasize case-based instruction. The theory further emphasizes context–dependent knowledge, knowledge construction instead of transmission, and introduction of complexity at an early stage of education. Cognitive flexibility theory stresses the importance of shifting from a single representation to multiple representations, from rote learning to knowledge creation, and from schema retrieval to situation-specific knowledge creation [24].

C. Practical Guidelines: Exploring and Reflecting

Some practical ideas for supporting active teaching and learning models can be drawn from the guidelines of the British Department of Education, which provides models of teaching and learning for primary schools, and which suggest a mix of various approaches to teaching [25]. Those approaches include, for example, interactive teaching, demonstration, coaching, visualizations, group problem solving, role-playing, and dialogic teaching. The guidelines advocate use of

TABLE I
COMPONENTS OF OUR LEARNING ENVIRONMENT

Component	*Method of Support*
Intrinsic Motivation	Support **competence** by encouraging teamwork, and providing effectance–promoting feedback. Support **autonomy** by providing choice and opportunity for self-direction. Support **relatedness** by promoting social interaction.
Constructionism	Maximize the **utilization of one-to-one laptops** in experimential and activating learning tasks.
Constructivism	**Avoid oversimplification** of instruction, **provide multiple representations** of content, encourage knowledge construction and case-based instruction.
Exploring and Reflecting	Support **group problem solving**, role-playing, and dialogic teaching. Use experiential learning principles. Support reflection.

metaphors, bridging of knowledge, and use of constructivist pedagogy [25]. In addition, the theory of experiential learning [26] stresses the importance of fostering the self-reflective, analytical, and evaluative creating processes of learners—a process of "active, persistent, and careful consideration of any belief or knowledge" [27], [28].

We also tried to keep an open mind towards the choice of pedagogical approach. We agree with Sfard [29], who argued that "*because no two students have the same needs and no two teachers arrive at their best performance in the same way, theoretical exclusivity and didactic single-mindedness can be trusted to make even the best of educational ideas fail.*"

D. Guidelines for the our Pedagogy

Our learning environment was designed to utilize the educational theories of intrinsic motivation, constructionism, constructivism and experimental, reflective practices. Table I shows our components and literature-derived ideas customized to our environment on supporting each of the components.

The "component" column in Table I presents each of the pedagogical components that we have adopted to our pedagogical bricolage. The "method of support" column presents the actual methods that we have used to promote each pedagogical component.

IV. RESEARCH QUESTIONS AND METHODS

The aim of this study was to explore the prospects and challenges of explorative, student-centered, and creative K-12 classroom pedagogy, which utilizes one-to-one laptops. The curricular component in which the pedagogical and technical components were applied was health care. We aimed at broadly collecting all available data and experiences concerning learning with laptops in this particular context. The explorative research aims of this study, the ontologically subjective nature of the subject matter, and this study's constructivist view of epistemology situate this research study in the radical humanist quadrant of Burrell and Morgan's classification of research paradigms [32]. In line with that paradigm, the main research questions for this study were:

- Research Question 1: How do elements of modern pedagogy and one-to-one computing contribute to the teaching of health care issues at Ukombozi school?
- Research Question 2: How does the participating local teacher experience the pedagogical and technical changes in the new learning environment?

To answer these questions, we collected detailed observation notes from each learning session and we interviewed the participating local teacher at the end of the course. The interview was a thematic interview, and it was tape-recorded, transcribed, and analyzed for points of convergence with the research notes.

This study was not an evaluative study but an explorative study, in which our intention was not to import and test a gadget (the XO-1 laptop) with some specific learning task, but instead to qualitatively explore pedagogical practices which would go well with one-to-one laptops, and which could address contextual educational challenges. In this type of research design, the results reported cannot be generalized "as is", since they are valid only in the particular context and setting. Lesh and Kelly [30] noted that the general aim of teaching experiments is not to produce generalizations, but to develop ideas "regardless of whether the relevant development occurs in individuals or in groups" [30]. Similar, Lincoln and Guba [31] stress the importance of single-group case studies by defining such a case study as "a slice of life" or "a depth of examination of an instance".

V. RESULTS

This section describes the course arrangements for health care course at Ukombozi primary school. Subsection V-A details learning objectives for each session, and analyzes course meetings, working methods, and the students' learning outcomes. Subsection V-B presents findings and analysis of the interview with the local teacher.

A. Course Description

To explore our ideas, we arranged with Ukombozi school an experimental course that teaches health care issues using the XO-1 laptops. The course was a compulsory health education course for the seventh grade students, which is the final grade in the primary school. Fifty-six pupils participated in the course, and their age ranged from 11 to 15 years, yet most of them were 13 years old. Few students had any computer experience before this course.

Together with one of Ukombozi's teachers, one of us worked as the main teacher in the workshop. The role of Ukombozi school's teacher was to help with Swahili language, help to maintain classroom discipline, and to observe and analyze the pedagogical changes. The course was divided to three phases over a period of five months: Two lectures per week, 32 lectures in total.

In the first phase, which consisted of 10 lectures, we introduced the pupils to the basic usage and working with computers before moving to actual teaching topics. During those lectures we let the pupils play freely with the computers, we encouraged exploration of the XO-1 laptop, and supported fun activities with entertainment applications on the laptop. The main learning objective in the first phase was to learn the

TABLE II
SUMMARY OF OUR COURSE SESSIONS

Phase 1 (10 lectures) Basic use of computers
Introduction to basic usage and working with computers before moving into actual teaching topics. Free play with computers, exploring XO-1 laptop, fun activities, and teaching computer topics. Main learning objectives was the basic use of computers: file system, keyboard, and track pad. Also: making notes, preparing small presentations with images and text, saving and loading files.
Phase 2 (12 lectures) Health care topics with new working methods
Teaching of health care topics, practical exercises, and new working methods to solve those exercises: poster preparations in groups and group presentations in front of class. Students prepared material on: basic health topics (hygiene, nutrition, effects of smoking, effect on sugar on teeth, and school bullying). Group games and role games.
Phase 3 (10 lectures) Advanced working
Increased challenge level. Teacher did not give correct answers to pupils but instead directed pupils to finding solutions themselves. Topics were advanced, and tasks were designed for self-directed learning. Encouragement of exploring and solving problems in groups.

basic use of the computer, file system, keyboard, and track pad. Students also learned to make notes, to prepare small presentations with images and text, and to save and load files.

In the second phase, which consisted of 12 lectures, we started to teach the health care topics. In the second phase we gave the students a number of practical exercises, and introduced new working methods for doing those exercises. The new working methods included poster preparations in groups and group presentations in front of the class. The students prepared material on basic health topics, such as hygiene, nutrition, effects of smoking, effect of sugar on teeth, and school bullying. We used group games and role playing to illustrate the topics. For example, in one game one of the groups played the role of a bully, other group was the bullied, and the rest were bystanders. At the end of the game, each group prepared a presentation about their thoughts, and finally presented their work.

In the third phase, the level of challenge was increased. The teacher no longer gave direct answers to pupils' problems, but rather guided the pupils to find solutions themselves. The topics were also more advanced and the tasks were designed for self-directed learning. We encouraged the pupils to explore and solve their problems in groups.

All the three phases followed the same pattern, where we first gave a short outline of the lecture, and then introduced various practical learning exercises. The role of the teacher was that of a facilitator and a coach, and not an drill instructor who gives orders. Such classroom setting and pedagogy are not common in Tanzanian primary education, where learning sessions typically make use of instructivist teaching practices.

The classroom activities progressed well, and we attribute a lot of that success to the motivating trigger-effect of the laptops. Due to technical difficulties, it was not possible to use the laptops in some sessions, and in those sessions the pupils were clearly less motivated to work. Table II presents a summary of the course meetings, divided to three phases.

The learning outcomes, pupils' working styles, and the tangible outputs of the workshop were impressive. Firstly, pupils swiftly assumed the new classroom setting, and their unfamiliarity with the situation did not bother them at all—though at the beginning the supporting teacher found the new setting unconventional. Secondly, pupils learned computer use quickly, and after the first 10 sessions they were able to do all the required tasks on the computers. Thirdly, through group work, exploration, and making presentations, pupils learned health care issues well. Pupils' knowledge in health care issues was measured by quizzes, in which the overall performance was impressive. Throughout the course, pupils' motivation level remained high and they were having fun.

If we analyze our experience in terms of our selected pedagogical viewpoints, as explained above, the results were positive. *Intrinsic motivation* was supported by giving the students some *autonomy* over their learning through many opportunities for self-direction. The *relatedness*–component was evident at the students' well-functioning group work. The *competence* component became especially visible in the second and third phases of the workshop, where the pupils had to struggle to come up with the answers. And when they did come up with answers, positive emotions were strong.

In the course of the workshop, the role of one-to-one computing in supporting *constructionism* became increasingly clear. Computers strongly increased the pupils' motivation and curiosity throughout the course. There again, if computers were everyday tools instead of a new and exciting thing, the motivational factor might be lesser. The *constructivist* elements in the course succeeded to avoid oversimplifying the topics of the second and third phases of the workshop. Students' *exploration and reflection* was most clearly visible in their self-directed learning of how to prepare presentations and give them, how to negotiate in groups, and how to succeed in various role-playing games.

Our subjective experiences, the documented learning outcomes, collected research data, and the material produced by children tell one story about the workshop. That story suggests that the workshop succeeded in implementing a pedagogical theory base—intrinsic motivation, constructionism, constructivism, and explorative learning—into practical classroom arrangements in health care education by promoting student-centered learning. That analysis would, however, be insufficient without a Tanzanian viewpoint to the workshop. Hence, we analyzed the workshop's success also through a thematic in-depth interview with the Tanzanian teacher.

B. Thematic Interview

A number of themes arose in the interview of the supporting teacher. The first theme was uncertainty with working with laptops. The second theme was the genuine, effusive enthusiasm and interest towards the use of laptops in teaching. The third theme was concerned with contextual factors that affect the use of laptops in teaching.

The teacher described that when the project started, teachers received no training for using the laptops: "*Just like one* [training session]*, not full training. . . . They just taught us how*

Fig. 1. Pupils in Work

to open the computer, and sometimes to write something. It was like this . . . and how to shut the computer." Although the teacher described how IT students from Tumaini University demonstrated and experimented with the laptops, teachers remained unsure about how the laptops should be used in teaching. The same concern has been noted by a number of critics of the OLPC Foundation (e.g., [6], [16]).

The second theme that the interview revealed was enthusiasm and interest towards using the laptops. First of all, the teacher had noticed that children were highly motivated to work with the laptops: "*The computer is a very good thing to be used in schools. When the children use the computers, they are very interested*." Concerning this particular course the teacher noted, "*I felt that students were enjoying very much to this, from your period . . . yeah, I think they are very interested to learn with computers.*" The teacher had started do develop his own ideas about how to start using the computers in the mathematics class. Concerning other classes, he thought that pupils could be able to save their notes and other work on the laptops instead of writing with a pen and paper.

The teacher started to plan how to use the laptops to bring the experimental pedagogy to mathematics classes: "*In mathematics they can . . . do in groups . . . yes they can do the solving of mathematical problems. Someone can know one way to solve this problem and the other does know this other way, and they can compare, which is short way to solve the problem*." The teacher also thought about new ways of using the computer for storing pupils' study materials: "*Because when we use computer, example if you have put your material in the computer, then it is easy to teach, just you put it on the table and they can see it from the computer. And there is firstly no time write on the blackboard, so you just see it on the computer. So I think it is good to use computer in teaching*."

The third theme that was brought up in the interview was concerned with contextual issues that affect teaching with laptops. The first issue was the need for translation of study material, as most pupils do not yet have strong skills in English language. The second issue concerned the lack of resources: the teacher mentioned a need for steady desks as an example: "*If there would be even steady tables .. with these tables, if you are not careful, it* [the laptop] *can even fall down .. because the tables are too small and they are not steady..* " The few tables are indeed third-rate quality with makeshift repairs and little thought for ergonomics.

The third contextual issue concerned lack of proper storage for the laptops: "*yes, this is because we don't have the storage room for keeping the computers. If we would have the storage room for all computers we should keep in school, but now the computer are far away. We take few of computer to teaching and the rest are still there*." The difficulty of bringing computers in naturally has a major effect on teaching. Due to this reason, most of the time two or three pupils had to share a computer even though in the remote storage room there would have been enough computers for all. The fourth contextual issue was that there was not always power to charge the computers—but that is an issue with Iringa in general and not Ukombozi School in particular.

Finally, the most fundamental obstacle for using the laptops in teaching was that the staff does not know how laptops could be integrated in the classroom. This point—teacher training—has been strongly made in the literature [6, pp.110–111]. The interviewed teacher argued similarly: "*Firstly, the teachers should know it very properly way. If the teachers do not know how to use the laptops, it will be difficult to teach. The problem is . . . we have to teach first the teachers to know it properly! Then it will be easy to teach the students*."

VI. Discussion

This paper reported the design and testing of a pedagogical approach that was contextualized to local environment of a primary school in rural Tanzania, and which was built on theoretical literature and documented experiences on one-to-one computing in education. Based on our results, we proposed outlines for a student-centered, explorative, and creative K-12 classroom pedagogy, which utilizes one-to-one laptops as a support tool. Working with a local teacher, we used this pedagogical approach, supported by XO-1 computers, to successfully teach health care issues. Our analysis shows positive results from a combination of a modern pedagogical theory base—intrinsic motivation, constructionism, constructivism, and explorative learning—and practical classroom arrangements in health care education. The motivating trigger effect of the XO-1 laptop in this learning environment was evident.

As an output of this research study we collected a large amount of practical classroom material and research data for further development of our pedagogical model in the Tanzanian primary school context. Contrary to some critics of OLPC Foundation, we defend the OLPC foundation's decision to leave specific pedagogical guidelines out. Because effective pedagogical strategies are context-dependent, one solution might not work equally well in a different context. For example, strength-based pedagogy, which utilizes the strengths of the pupils and teachers in each specific context, can hardly

be modeled into a single set of universal guidelines. As an alternative for generic pedagogical solutions, we propose a smörgåsbord database of "best practices" in one-to-one computing in developing countries.

In our further work we continue to work with Ukombozi School's staff to further explore and experiment with the pedagogical approach developed in this research study. Our main future research interest concerns the extension of this pedagogical approach to other school subjects, and the transfer of our model into the repertoire of all Ukombozi's teachers. We wish to involve other teachers and staff more deeply in the research. As our interview with the local teacher confirmed, there is interest and enthusiasm, but also a lack of skills. The transfer of working pedagogical models to the repertoire of local teachers—teacher training—is quintessential for the future. In this particular culture, if a teacher is not well familiar with the computer, that teacher is often reluctant to utilize computers in the classroom.

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