

Design milieux for learning environments in African contexts

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Abstract

During the years 2002 to 2009, five African settings were used as foundation for designing different learning environments. While the content and target group for each learning environment varied, all of their design settings, or milieux, shared one implicit expectation: the milieu should facilitate the production of a change-making learning environment. A retrospective qualitative analysis identified a set of 10 common indicators that describe how successful a given setting is as a design milieu for creating learning environments. The study shows that for each design milieu indicator, a milieu can feature success and failure at the same time. The results, novel in their emphasis on the design setting rather than the use setting, can be used for both assessing the prospects of a particular milieu and improving its strengths for design opportunities especially in African or other developing contexts.

Introduction

From 2002 to 2009, we designed technology-based learning environments for diverse contexts in two countries in Africa. They varied from dream workshops in a poor primary school in Tanzania to after-class technology clubs in South Africa, to learning programming at secondary and tertiary level in rural and urban Tanzania. A crucial aspect of these interventions was the emphasis on participatory design (Schuler & Namioka, 1993) that was based on the available resources and strengths, rather than the needs, of the contexts. The common expectation of the designed outcome—whether an artifact or an educational framework—was the *change* that it would cause among its user context.

Complementary or even contrary to the current study, the mainstream educational technology research, aims at identifying the difference that technology makes to education. Hence, the emphasis on the analysis of the usability, learnability or functionality of various tools in real or artificial educational settings. These allude to natural and essential questions for educational contexts that have both *access* to and *ownership* of technology. In broad terms, access refers to the availability of technology, in the meaning of universal access, whereas ownership requires that the users can express themselves through the available technology. The World Wide Web Consortium (W3C) emphasizes the access rather than the ownership (“W3C Mission”, 2012).

Both Tanzania and South Africa, however, have problems in the access to and ownership of educational technology. Limited access requires approaches complementary to broadband connectivity. To overcome the lack of ownership, learning communities need to be involved in the

Practitioner Notes

What is already known about this topic

- The milieu is an important factor for contextual design.
- Transfer of applications and technology from a developed context to a developing context often leads to poor results.
- For contextual design the target group should be considered and preferable involved in the design process.
- Designing in the reality helps overcoming the design–reality gap.

What this paper adds

- Analysis of designing in modest settings of developing countries.
- Identified crucial success or failure factors in designing learning environments in an African context.
- A framework that can be used for improvements or descriptive analysis of design milieux.

Implications for practice and/or policy

- The framework can be used for analysis, assessment or quality assurance of an existing design milieu or its further development.
- The analysis can promote a dialogue between the different stakeholders in order to improve the success of the designed intervention.
- Relevance for the renewal of the proactive integration of information and communication technology for education elsewhere.

design process itself, to guarantee contextual relevance of the learning materials and tools. Thus, each context needs its own technical solutions for education. Traditional transfer of technologies or concepts is not enough. Therefore, the focus of this paper is on the characteristics of the *design place*, to be called *design milieu*, of educational technology in African contexts similar to those selected for this study.

While the word milieu is synonymous to surroundings, setting, scene, environment, element, background, location and sphere, its etymology refers to middle-ness. Hence, in this paper, design milieu refers to the natural essence of the context in which the design process takes place. Milieu includes social and cultural aspects of the people involved in the process as well as the conditions of their surrounding reality: physical location, available infrastructure, educational background, ambitions and goals imposed through the context. In the terminology of educational technology, the concept of *environment*, like in learning environment, has assumed a somewhat artificial connotation, as a built, constructed environment, hinting to a result of a design process in an isolated laboratory. This has caused the well-known design–reality gap (Heeks, 2003) that, among other things, has made the crafted learning environments conflict with the realities of their users, especially in African and other developing contexts. A natural design milieu should ensure that the created artifacts or frameworks function—ie, cause a change—in practice. *The main difference between a developing and a developed context is that most design takes place in a developed context; whereas technologies are used in both kinds of contexts, bringing about the design–reality gap in most developing contexts.*

Rather than analyzing only the outcomes of the design process post hoc, we focus on the entire process starting from the origins of the designed interventions. We show that even a

technological periphery can be (transformed to) a creative milieu. For our research, the role of a natural setting, a design milieu, is a source of inspiration for design that change the learning experience of a user that is native to the same design context.

The emphasis on a physical place can be seen in the vast array of development projects in Africa by which international donors channel thousands of millions of dollars to infrastructure development that, in the area of educational technology, easily reduces to establishing units like Community Multimedia Centers (Vannini, Rega & Cantoni, 2012). These developments highlight the expectations that Africa can create, not only consume, and that there will be a physical milieu that makes a difference. Our focus is thus, not the learning outcomes reached by the designed tools, but the milieu where the design itself took place. The term environment has a strong connotation to the context where the consumption, not creation, of educational tools takes place. This is also why we prefer the term milieu instead of environment.

The research of the paper is centered on identifying *indicators* that explain the success or failure of a given milieu in its challenge to design a functional leaning environment. The research questions are as follows:

- 1 What are the common indicators within the five diverse design milieu?
- 2 How can the indicators within a given design milieu be measured?
- 3 How can the indicators be used to improve an existing design milieu?

The paper is organized as follows. The second section positions this study within the research landscape of learning environments, creative milieu and information and communication technology for development (ICT4D). The third section introduces the research design. The fourth section itemizes the analyzed design milieu and their scoring scheme, followed by the fifth section for the analysis of the results. We interpret the results and their limitations in the sixth section.

Background

This study takes place in the intersection of the research fields ICT4D, learning environments and creative milieu (Figure 1). Using ICT for change and development is what gives us the motivation for the study as ICTs can improve the quality of life for the world's neediest people (Dias & Brewer, 2009). However, often applications and technology have been transferred or duplicated from a developed context to a developing context with poor results (Unwin, 2009). For ICTs to benefit

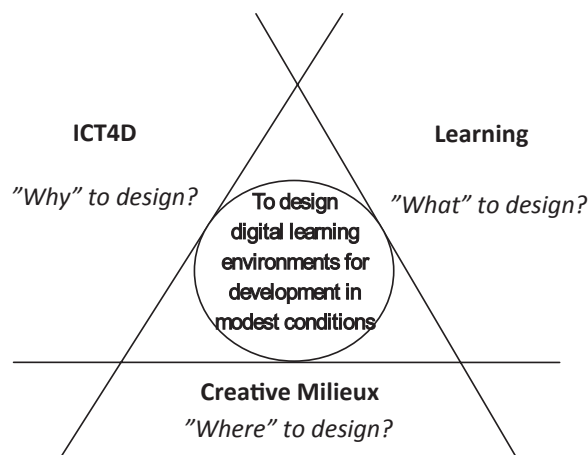


Figure 1: Positioning the conducted research

developing communities, it is important to ground them in the context. This is best done by involving users in the design of the ICT-based interventions.

One of the key pillars for change and development is education where ICTs can enhance the quality of a learning process. Creating relevant solutions for local demand requires mastery of available technology, in some cases even programming. Youth should not only be taught to be users of technology but should be given the opportunity to be creators themselves (Maloney, Peppler, Kafai, Resnick & Rusk, 2008). In designing learning environments, in particular, we need to cater for the affective, social, cultural, historical, cognitive and philosophical interactions within the context (Thomas, 2010). Cultural practices, traditions, languages, beliefs and livelihoods must guide the design processes for successful educational solutions that aim at development (Dias & Brewer, 2009).

Contextually relevant changes for education require creativity in the design process for learning environments. Creativity is essential for new innovations (Kultima & Paavilainen, 2007)—inventions that work in practice—to take place and can be seen as applied imagination. However, often creativity is associated with urban and developed, rather than rural or developing contexts. Typically, creative places are considered places where newcomers are quickly accepted and where anyone can fit in, where people can be themselves and not get stuck in any one identity. Creatively minded people enjoy a mix of influences, they want to socialize with people that differ from themselves and they favor active participatory recreation over passive institutionalized forms (Florida, 2002). It has been found important for cities to foster a creative atmosphere where innovations can take place. While looking at what constitutes a Creative City it has been found that it identifies, nurtures, attracts and sustains talent so it is able to mobilize ideas, talents and creative organizations (Landry, 2000). Contrary to literature, we are looking at the creativity and potential of creative design milieux in modest and poor but developing contexts.

Change is the common agenda for the three fields. ICT4D aims at better life by technology. Learning environments aim at changed knowledge, skills or attitudes as learning outcomes. Creative milieux would imply generation of innovative ideas leading to change. Somewhat surprisingly, within developing contexts change has not been emphasized in any of the three fields. Information systems oriented ICT4D research has mostly been evaluative, which has made it conservative (Walsham, 2012). In digital learning environments, the focus has been on cutting costs and transferring the same learning curricula and materials only through a new medium rather than changing and innovating the learning itself (Cronje, 2006). Creative milieux have not been supported and emphasized enough in most African school systems as creativity is difficult to control and can lead to a change that is often considered more threatening than desired (Minette, 2012).

Setting up a digital laboratory in a foreign context is not sufficient. The design process must be determined by the context where it takes place (MacCormack & Verganti, 2003). Design milieu as we would like to see it should be a place for designing ICTs for learning that makes a difference. The emphasis should be on revealing and utilizing the local strengths and make use of available resources rather than focusing on the needs. Often there is a strong focus on addressing the needs, which does not necessarily enable the strengths and talent to benefit the design for improved results or outcomes. In our case, we have been working together with schools and students towards setting up creative design milieux on grassroots level.

Research design

Our research design is based on the design science paradigm (Niederman & Salvatore, 2012). Thus, the emphasis is on construction rather than qualitative or quantitative evaluation. Our agenda has been to construct learning environments in various developing contexts that we call

design milieux. The purpose of the learning environments has been to cause a positive change among their users. Therefore, they have been designed in close collaboration with users, following participatory design or user-centered design approaches which, naturally, require analysis, qualitative, quantitative or mixed methods (Schuler & Namioka, 1993). The analyses of design processes and their end results have been reported in other papers (fourth section). The goal of this paper is to collect our analyses of not the products but the design milieux into a meaningful model—a typical product of a design-science-based study. So, we follow the approach of participatory design but from the viewpoint of design science.

Over a period of 8 years between 2002 and 2009, the first author was working with five different educational technology projects that employed participatory design (Table 1) for various interventions as illustrated in the table, four of them in Tanzania and one in South Africa. A key challenge was to establish a creative and innovative milieu, empowering students to express their ideas through technology. Figure 2 illustrates the steps of the process followed in this paper according to the development research approach (Van den Akker, 1999). Steps 1–7 belong to three main phases.

Phase I. Collecting the primary data (step 1)

The experiences from each design project informed the design of the next one. Primary data from all five projects was collected in the form of research diaries, research publications, designed artifacts, pictures, videos and project reports.

Phase II. Generating the list of indicators (steps 2–4)

A retrospective analysis of the projects combined the primary data with the first author's memories and reflections into the systematic representation of secondary data. The secondary data itemized the strengths and the shortcomings of the milieux. From the data, we identified noteworthy aspects that contributed to success or failure of each project. The list was intended to cover aspects of diverse design milieux. It was the input to the list of indicators that captured the successes and failures of the diverse milieux. Phase II was repeated until satisfying secondary data descriptions, and lists of aspects and indicators were obtained.

Phase III. Code book for the scoring of the design milieux (steps 5–7)

Once we had an extensive list of indicators, we derived a code book for scoring the indicators in regard to success and failure in the interventions. We realized that in the same design milieu one indicator could indicate success and failure simultaneously. For instance, design milieu 1 had support from the leadership for learning programming and ICT literacy. The support turned into control as the students used their skills to design a website for HIV and AIDS education: the leadership considered the designed material inappropriate. The initial strength of support transformed into its opposite; the code book needed to cater for both aspects. Therefore, each indicator needed to be rated on the success as well as the failure. A scale between 0 and 3 for success and 0 and –3 for failure was chosen, as a larger scale would have made the code book too complicated and a smaller scale would not have been able to well enough capture the different levels of success and failure. The code book specified the criterion for each score to be given. Using the derived code book we scored all the interventions.

Once we had satisfactory milieu descriptions, indicators and the first version of the scoring code book, we sent them to colleagues that had been involved in the design projects and had them calibrate the model by providing alternative scores and comment upon the milieu descriptions and choice of indicators. From their feedback, comments and understanding we made further adjustments to the scoring code book (step 5) and to the milieu descriptions (step 2). The fact that each design milieu had a colleague with a complementary role (see the fourth section) improved the focus of the scoring book as the instrument, thus adding to the validity of the research.

Table 1: Overview of the five different design milieus

Design milieu	Place of design	Level	Primary learning contents	Intervention and its technical platform	Design team in addition to the researchers	Secondary learning contents
1. Kidugala Sec. School	Kidugala, Rural southern Tanzania (2002)	Secondary school (after classes)	Java programming	Web materials, Java applets	15 students and one school teacher	HIV and AIDS
2. Tumaini B.Ed.	Iringa, Urban southern Tanzania (2003)	University, B.Ed.	Java programming	Web materials, I-BLOCKS	27 Students, 1 teacher	Robotics
3. TekkiKids	Pretoria, Urban South Africa (2007)	Primary school (after classes)	Creativity in the design process, engineering skills	Framework for starting technology clubs in South Africa	36 students, 5 teachers (one from each school)	Programming
4. SuraYa UKIMWI	Iringa, Urban southern Tanzania (2008–2009)	Primarily secondary school	Design and implementation of digital multimedia	Web materials, CD, book based on stories; Flash	6 schools involved, 70 students in total	HIV and AIDS
5. Dream workshop	Iringa, Urban southern Tanzania (2009)	Primary school	Digital storytelling	Multimedia stories, OLPC XO-1	17 students, one teacher, 3 university students	Life skills

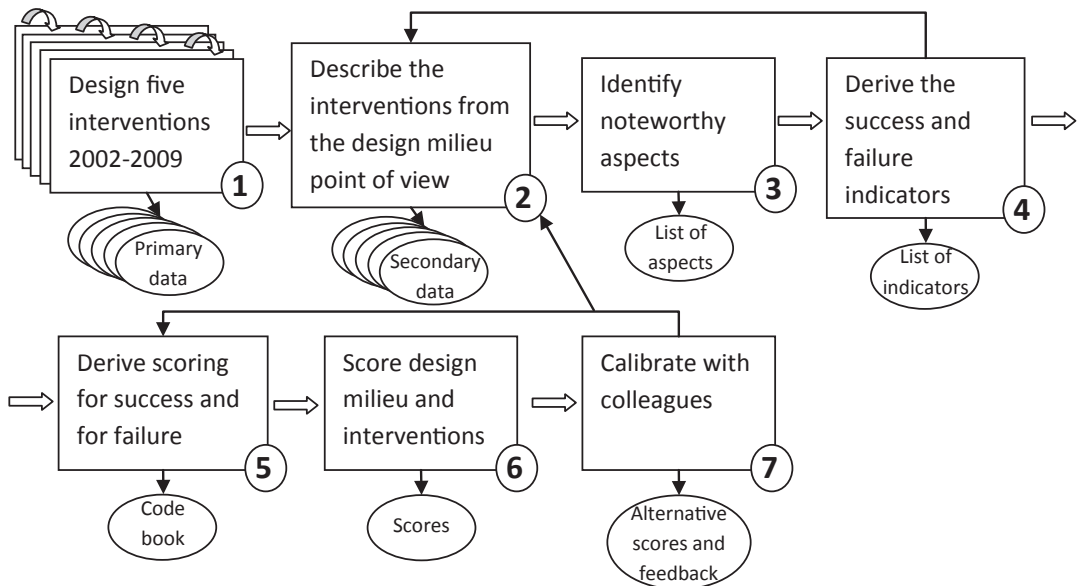


Figure 2: The research process

The development of the model was an iterative process between the phases. We first needed to go back and update the milieu descriptions according to the selected indicators. Secondly, we needed to update the milieu descriptions according to the scoring criteria. Thirdly, we needed to update the descriptions and scoring criteria according to the feedback from the co-designers. The iterative character is typical of a design-science-based research design.

The design milieux

The five design milieux involved participants from a variety of educational levels from primary school to university (Table 1). Design approaches varied according to the learning goals and contents (Figure 3).

The design milieux and their interventions were as follows:

Design milieu 1: For 2 months, secondary school students in a rural village in Southern Tanzania were taught programming in order to investigate how programming can be made meaningful to the students. A JAVA programming course was given to the secondary school students. The course was organized as an after-hours activity at the school. The first half of the course was spent teaching the basics of Java programming while the second half was spent on a joint programming project where students produced material for an online HIV/AIDS educational platform (Duveskog, Sutinen, Vesisenaho & Gasso, 2003). The analysis of this milieu was calibrated with a colleague who participated in the design process and who was a volunteer at the school working with health education.

Design milieu 2: The design took place for 3 months with the target to develop a contextualized Java programming course together with Tumaini University. Improvements were made in the following year when the same course was given to B.Ed. students at the university. The learning materials consisted of educational robotics referred to as I-Blocks (Lund & Vesisenaho, 2004), the Jeliot programming visualization tool (Moreno, Myller, Sutinen & Ben-Ari, 2004) and tailor-made web-based learning materials (Vesisenaho, Duveskog, Laisser & Sutinen, 2006). The analysis of this milieu was calibrated with a colleague who was doing his PhD that was based on the outcomes of this intervention.

Design milieu 3: During the period of 1 year a framework for technology clubs for South African primary school children was designed. The intervention took place in Pretoria. The five participating schools represented both well-resourced, predominantly white schools, as well as less resourced, predominantly black schools. The children were to learn engineering skills as well as robotics and programming. The technology



Figure 3: Pictures from the five different design milieus show the diversity of the contexts and activities. Student programming Java Applet, students programming by building, student designed robot, Sura Ya UKIMWI platform, Dream workshop group picture

clubs were designed to accommodate schools independently of their resources (Marais, Duveskog & Dlodlo, 2008). The analysis of this milieu was calibrated with a colleague who was also managing the project.

Design milieu 4: For 9 months a digital platform for HIV and AIDS education and counselling was co-designed together with Tanzanian youth, mainly from secondary schools. The story based digital platform was based on true, real-life stories. The content was designed by Tanzanian youth while the researcher compiled the material into a booklet, an online platform and a CD-based platform (Duveskog & Sutinen, 2009). The analysis of this milieu was calibrated by the person managing the counselling project that this intervention intended for.

Design milieu 5: For 2 weeks, a multimedia workshop related to the dreams of primary school children was designed together with semirural primary school students in Tanzania. The school had received 100 XO-1 laptops that were used as the design tool. A story-based platform and game was related to students' dreams. The process required students to reflect upon important life decisions and how to overcome life challenges (Duveskog, Islas Sedano & Sutinen, 2010).

Results

List of success indicators of design milieus

The 10 indicators we used for evaluating success or failure in this model include the creative engagement of the designers, the support from leadership, the sense of ownership in process and product, the freedom of expression, the development of skills, the availability of technical equipment and resources, the quality of the intervention, the achievement of goals, spin-offs and the

openness to outsiders. Each indicator can be scored between 0 and 3 for success and between 0 and -3 for failure, according to the code book in Table 2.

Scoring codebook for success indicators

With the help of the code book we were able to score the design milieux. We can get an overall score in the form of a “total score” taking into account scores for all indicators as well as the simultaneous success and failure of a specific indicator. By placing the scores of each indicator into the success/failure graph we can get a graphical overview of the strongest success and failure factors within the given milieu (Figure 4). The numbers in the rings corresponds to the number of the success indicator in the code book. As seen from Figure 4 the indicators often simultaneously indicate both success and failure.

The tool can be used for a descriptive analysis of design milieux at different stages of a project and provide indicators as to what extent the project will be successful. The indicators 7, 8 and 9, however, come into play only at later stages or after the project is completed.

If results fall within the gray area (Figure 5), it indicates a dependency between success and failure while if the results are outside of the area it indicates that the success is not directly dependent on the failure; in other words, a success indicator can indicate both failure and success independently. No success or no failure refers to being at a starting point of the success/failure dimension. In a way 0 = potential/latency and 3 = fully realized/manifest.

In particular, scores in the conflictive zone (D) would indicate that the design milieu has significant potential, with simultaneous threats.

The model for analyzing and improving design milieux

The devised model can be used in analyzing and improving design milieux other than those presented in this study. By having stakeholders within the design milieu to score the milieu, they will be able to identify the potential success factors and failure threats. From the two-dimensional representation of the scores the stakeholders can get an easy overview of the situation. Based on the results they can take necessary actions to improve the design milieu and thereby increase the chances for success from the designed intervention. At the same time, the devised model—the combination of indicators and their scoring code book—works as a platform for a dialogue where different stakeholders can portray their different or even conflictive impressions of a given milieu. Figure 6 shows an example of the different scores given by the author and a colleague for one of the milieux (see the fourth section).

Discussion

The credibility of the results is supported by the round of scoring by colleagues with their own memories and latent information improving the reliability of the secondary data and the scoring code book. However, when scored by different persons, there were some diverging results due to subjectivity or different interpretations of the scoring scheme. There was coherence though in what were the stronger success—and failure factors. So even if people have different opinions, the tool still provides a visual framework where we can easily portray the different stakeholders’ analysis.

The current study is a cross between a longitudinal development research, design science and a qualitative retrospective analysis of the design milieux as well as artifacts and concepts obtained during the years. Hence, the results share many of the advantages and concerns of any study based on a similar approach. The real-life settings and pragmatic learning goals contribute to the contextual relevance of the results, and their diversity to the transferability of the scoring scheme.

Table 2: Scoring code book for scoring of the design milieu and intervention

Success Indicators	Major success +3	Success +2	Minor success +1	No success 0	Major failure -3	Failure -2	Minor failure -1	No failure -0
1. Creative engagement of student designers	Group of students are excited, active, creative, share own ideas and ask questions	There are students that are creative and innovative	Students participate and try but are not creative	None of the students are engaged	Most students drop out and/or show little engagement	Some students drop out, lose interest and take shortcuts	Few students show lack of interest, drop out, lose interest or take shortcuts	No students show lack of interest
2. Support from leadership	Active support and showing great interest	Show interest and are supportive	Shows some interest	Do not display any positive attitudes	Discouraging and work against the success	Condition and complicate the process	Shows some mistrust or skepticism	No negative attitudes encountered
3. Sense of ownership in process and product	Students represent their own ideas. Students feel in charge and are proud of their product.	Students' ideas are considered in the design process and represented in the material	Students are involved in design process but share only a few of their own ideas in the product	Level of the students' contribution and representation in the product design and process is minimal or non-existent	A researcher or an outsider directs the process with no concern to the students' views or ideas	Shortage of originality or students only participate in parts of the design process	Students do mostly what they think is expected or copy ideas	Students are allowed to contribute
4. Freedom of expression	Students open and free to express themselves even with personal issues without feeling judged	Students are able to express themselves freely on occasions during process	Milieu is relatively open but students do not really open up	Students do not express themselves	A very controlled environment where creativity and own expression is discouraged	Strong factors limit students' ability to freely express themselves	Boundaries on certain areas where students cannot express themselves	No limitations in freedom of expression noticed
5. Students developed new expected and unexpected skills	Students actively developed a wide set of expected and unexpected skills	Students learned well according to expectation	Students performed well in some aspects	Students did not learn new skills	Students did not develop new expected and unexpected skills	Students failed to learn some of the key skills needed	Students did not learn some needed skills	No shortage of skills in design process registered
6. Technical equipment and resources	The resources and equipment where enough and contributed to the success	Available resources were somewhat utilized without it limiting design process	Resources were insufficient but design could still take place	Resources were not utilized	Equipment and resources were insufficient and strongly hindered the design process	Shortage of resources affected the design process negatively	Some limitations due to lack of resources	Lack of resources did not affect design process
7. The appearance and usefulness of the intervention	Is useful and unique and people can learn from it and relate to it	Appearance and usefulness of the intervention is satisfactory	The intervention was found to be somewhat unique and useful	The intervention provides no value add	Found inappropriate and useless	Not found useful	Partly low quality and not unique	Nothing really negative about the intervention
8. Achievement of goals	Exceeded the pre-set goals and expectations	Reached the goals and expectations	Some goals where satisfactory reached or exceeded	No success in regard to the achievement of goals	Major failures with regards to the goals	Some goals failed	Minor failures in regard to the goals	Goals did not fail
9. Spin-offs	Plenty of positive spin-offs as a result of the intervention	Some important spin-offs as a result of the intervention	Some spin-offs or plans for further activities	No spin-offs recorded	Major negative implications of intervention	Negative implications of intervention	Minor negative consequences of intervention	No negative consequences recorded
10. Openness to outsiders and new ideas	Outsiders are warmly welcomed and their ideas are valued	Outsiders are welcomed and they ideas are considered	Outsiders are conditionally welcome	No sense of openness to outsiders	Hostile towards outsiders and ideas from outside	Some hostile attitudes shown towards outsiders	Skepticism towards outsiders and their ideas	No negative attitudes towards outsiders

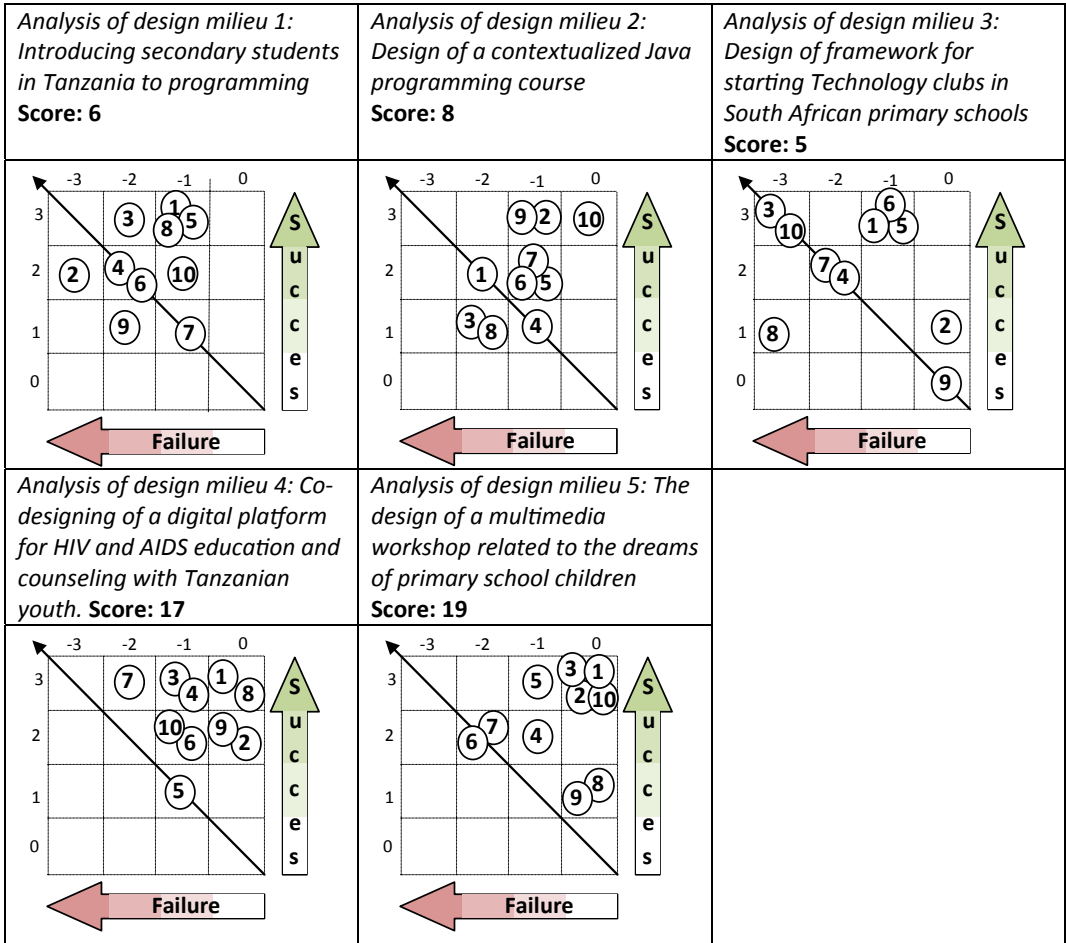


Figure 4: Scoring of the milieux, showing the scorings given by the first author

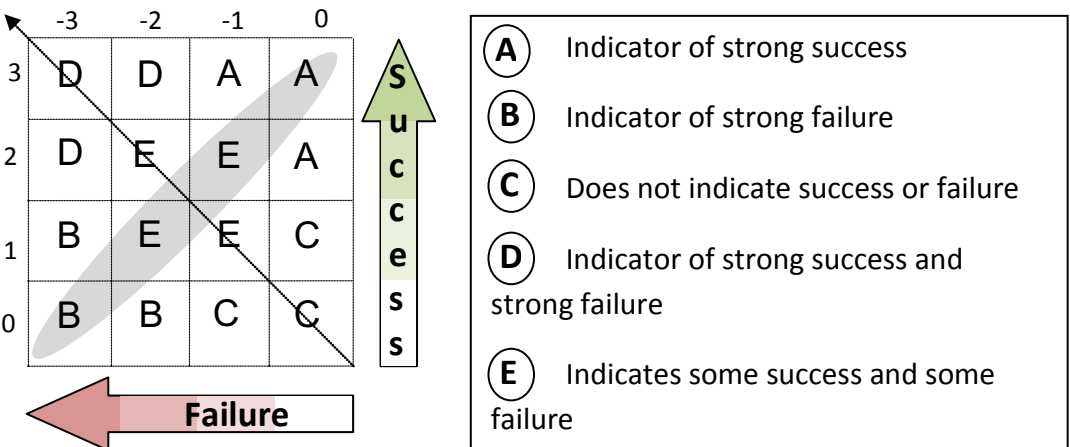


Figure 5: The scoring options for each indicator

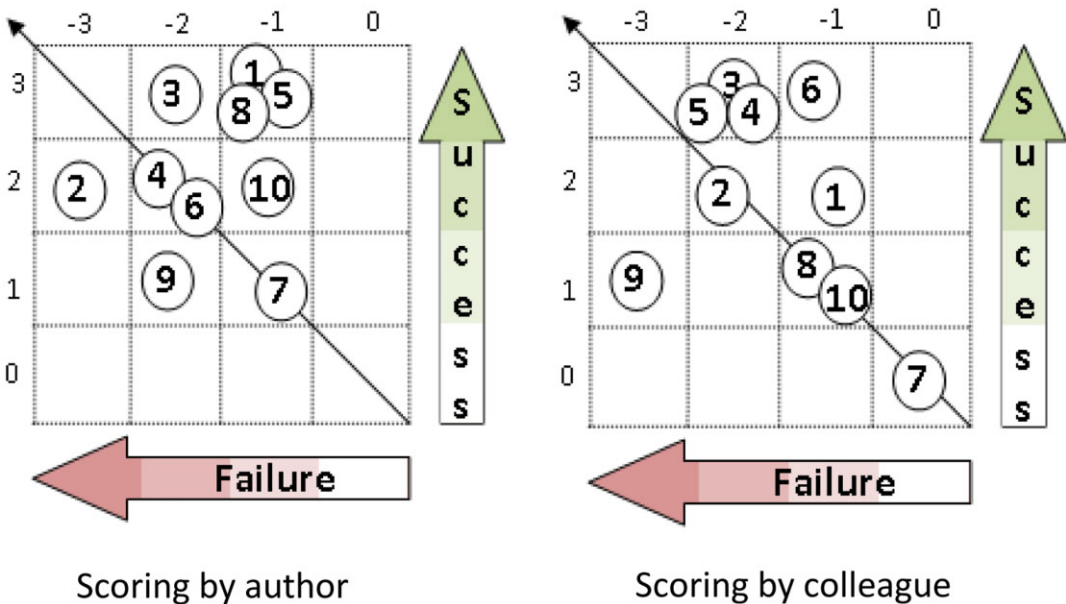


Figure 6: The scoring of milieu 1 by the first author versus the scoring by a colleague

Aspects missing from the primary data yield weaknesses in the scoring scheme. For example, the scheme does not cater for personality of the key persons involved in the design, although these people are key factors of a milieu. We also believe that a set of personal skills such as adaptability to new contexts and conditions, teaching skills and ability to understand and communicate with the co-designers together with personal drive and dedication influence successes and failures. This example shows that, although we claim that the approach is valid to answer the research question, the scheme is not comprehensive, due to missed aspects in the descriptions: this weakens the validity.

A key result of the paper is the fact that a given design milieu can—at the same time—feature success and failure as measured by a single indicator. This can be understood by Heeks’ design-reality gap (Heeks, 2003). Even in a design milieu that exists in the intended users’ reality, the designers might follow their own ideals that are not valid in the context. For example in one case the leadership of the school gave free reign with respect to introduction of technology at the school; however, when the students designed a website for HIV and AIDS education that was in conflict with religious beliefs, they prevented it from being published or accessed on the Internet. This case illustrates this inherent tension between success and failure, or ideals and reality.

Conclusions

Using a set of five diverse design milieux, we have introduced a scoring scheme that identifies and analyzes the common aspects, characteristics and attributes that shaped the design and contributed to the successes and failures in the design projects and interventions in these milieux. What we have derived from this research is a tool for descriptive analysis of design milieux. We needed diverse real contexts to be able to identify common characteristics. One of the key results was that we managed to find indicators that can simultaneously show success and failure.

The resulting scheme can be used for both an analysis of an existing design milieu or its further development. We believe that the analysis can promote a dialogue between the different stake-

holders: the ranking scheme accommodates at the same time ratings that are opposed to each other. A visual representation, we hypothesize, encourages analytical argumentation on the pros and cons of a particular milieu.

The study opens horizons for further research. In this paper, we were more interested in indicators for success and failure of the design process and its milieu than the learning environment and its use. In the future, it will be interesting to analyze the relationship between the design milieu and the usability of the designed product in the original or an alien milieu, or even the relationship between the design milieu and the use milieu, that is, how can a product designed in a promising milieu be used in an innovation-hostile milieu.

In future research we need to take measure how the tutors manage to cope with the design milieu and the interpersonal roles in achieving success and avoiding failure. Although the scoring codebook was calibrated by interacting with the colleagues that were involved in the design processes in various milieux, an interrater reliability test of the scoring within an existing design milieu is crucial to improve the code book and, hence the validity of the code book. Another opportunity, although technically demanding, to improve the objectivity of the assessment of the design milieu is to use natural language processing techniques for automatic scoring, based on designers' textual descriptions. This approach can be used particularly within a design milieu's formative evaluation.

We did not analyze the dependency between the indicators, which would also be a matter of further research. Prospect for future research would also be to use it among stakeholders in a design milieu and record on the discussions and evaluate how it can help guide the design.

Based on the 8 years of designing digital learning environments in diverse African milieux, we expect that the research carried out in Tanzania and South Africa has relevance for the renewal of the integration of ICT for education elsewhere. The renewal is based on rethinking the origins of the learning environments, and their design milieux.

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