Enabling Individualization and Constructionist Learning in Austrian Public Schools

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Abstract
Public education in Austria is in big trouble, one might think – improving the school system is an immanent effort. Improvements, so we argue, could be easy but require a cultural and conceptual change in teaching. Looking at evidence about the individual learning process and providing diagnostic tools to teacher and learner can make a substantial difference. In this paper we provide insights into project activities and analyses of constructionist learning approaches. The scientific support comes from the EU FP7 Next-Tell project which is providing learning analytics support focusing on the real-world constraints of the European schooling context. We argue that even a very simple but smart competence-centred ICT-supported approach is highly valuable – and given the very diverse audience in most of Vienna's public schools - can give teachers a convincing support of formatively inspired, personalized teaching.

Keywords individualization, constructionism, learning analytics, adaptive learning analytics

1. Introduction

1.1. Managing a Diverse Audience

Vienna is one of the fastest growing cities in Europe [1]. This leads to a growing demand of additional school capacities, which in turn is resulting in a significant need of investments in school infrastructures. In the next decade authorities estimate a need of more than 230 new classrooms. A significant number of young people entering the schools have an immigration background; many of them with little or no German language literacy [2]. In this paper we present our experiences of working with two cooperating classes in primary school with 47 pupils speaking 13 different first languages. Only 3 pupils have the German as their mother tongue. This extremely diverse situation is quite typical for most districts in Vienna today.

Usually, today's teachers attended more homogenous systems in terms of cultural and socio-economic backgrounds. Also, the education and training of teachers did not address (and still sparsely addresses) the issue of cultural diversity at a level that is required to cope with the educational reality today.

Although the context conditions are a burden and require extra efforts, ideally, the growing diversity should be considered being beneficial for a broad and modern education. Pupils are bringing in additional languages and social contexts, different experiences and perspectives. One might argue these are "treasures" because our lives today are intertwined on a global level and a better understanding of other cultures and an increased exchange, and collaboration can be seen as a "21st century skill".

On the other hand, this diversity is a substantial burden, requiring a much more individualized approach to education. In consequence more attention and time is required to assess and respond to individual situations in pupils' learning. We believe that many teachers lack the resources, experiences, and trainings to manage this kind of audience and context conditions successfully and effectively. A mere increase of school expenditures, which presently occurs [1], is not resulting in a

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measureable impact and improvement of the situation [2]. In the paper we describe a practical approach to improving the situation and better supporting teachers and learners.

1.2. Learning Analytics as Key for Enabling Individualization and Constructionist Learning

As a simple example, one might believe that diagnostic instruments in medicine have improved over the last century. In a hospital, usually, patients are examined, observations are made, and various parameters are measured as basis of a diagnosis that in turn determines medications and therapies. Clearly, a physician is not prescribing the same treatment to every patient but treats each person on a highly individual level. Although this is a trivial statement, it cannot be transposed to the schooling system.

In schools most often everybody is educated with the same contents in the same curriculum and learning plan, using the same strategies and means. "Personalization" often is only made on the basis of the day of birth and type of school the person is in. Such kind of "one fits all" approach, unfortunately is standard in Austrian schools [5]. Of course, in theory every teacher could (should) document observations and analyse them in order to assess the learning status of individual learners and respond to such observations; and actually this is what teachers are usually attempting. Given the fact that each school subject has between 100 and 300 different competencies as learning goal [6], and class sizes range between 20 and 30, it is challenging for a teacher to find the time to do all the documentation and analysis needed to realize something like individualization of teaching or formative assessment and guidance. This is particularly true when a teacher is required to teach in total 200 to 300 students, as it is common in secondary schools.

In the Next-Tell project [7], a joint European research and development initiative, co-funded by the European Commission, we aim at addressing the issue of supporting formative assessment and individualized teaching within the context of limited resources (of teacher time and technical infrastructure) by developing appropriate software tools to support planning, monitoring and providing feedback both on classroom and institutional levels. The focus is on formative assessment support and -feedback. In practical application we found, that the individual diagnostic capabilities are the most valued by teachers in the classroom.

Research in pilot classes, for example, involved constructivist learning environments (such as virtual worlds), long-term evaluation projects, and data acquisition activities in European classrooms. We started with projects in a virtual world like creating learner made videos (machinima) focussing "in depth" analysis. Later on we added physical world projects like creating learner made videos in a physical setting embedded in a broader analytical context.
A distinct finding was that the ability to embed analysis in a "holistic" context is a critical success criterion for developing formative assessment and feedback strategies in classrooms. Also, we fund some evidence that a systematic "learning analytics" [14] approach on a simple but complete "full day" capturing of main learning activities in the classrooms appeared to be most beneficial for teachers to get a novel and deeper insight into student's learning processes.

2. Pilot Studies: Constructivist Learning Environments

2.1. Drilling Deep: In-depth Analysis Using Virtual Worlds as Learning Environments

Virtual worlds (e.g., OpenSim or Second Life) bear two major advantages; on the one hand, a virtual enables a free exploration and self-controlled construction of new knowledge in real contexts. In rich simulations innovative insights can be given, students can walk through the ancient Rome or experience the functioning of the human body from inside the body cells. Contrasting the pedagogical advantages, virtual worlds enable the recording of a massive amount of students' activity data, which in turn allows a very detailed and deep analysis of learning. We utilized these benefits for example in second language acquisitions projects in different secondary schools [8, 9].

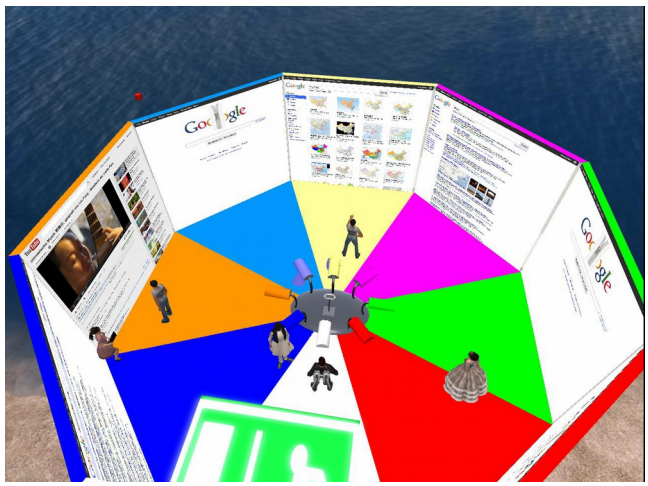

Figure 1: A virtual brainstorming session with students.

Virtual worlds offer a great potential for constructivist learning, as constructing (e.g., building and using objects) is cheap and easy. The room setup shown in Figure 1 would be equivalent with a classroom where every student has his own video projector simultaneously. By such means, project work between students, in this example a brainstorming and decision-making session for a student-project, can be very efficient in terms of learning output. Also analysis for teachers can be very deep, as written and spoken word, behaviour and context can be captured and is available for reflective analysis.

Learners liked this kind of approach and highly appreciated the freedom of the virtual environment and often want more of it because they are empowered to shape everything from their avatar to the environment and of course their project. Unfortunately, there are technical and organisational constraints which make the use of such an environment not practical. Setup times are still too high, the technical infrastructure (especially in school) are still not reliable enough. Our finding was that as long as such an environment is not used on a routine basis it is not economical to be used at all. These obstacles need to be addressed by next generation virtual world environments for education and educational organization.

A concern that was raised by teachers was that the insight gained for the learning process where very specific and at best useful for a very small number of competencies. If there are 100-300 competencies to cover [6] (e.g. in secondary language acquisition) knowing about the learning processes of two or three of them is helpful but doesn't help too much with the big picture, including all competencies. The effort made gaining this specific insight might not be rational because there are so much more competencies which need attention. As a consequence, we had to conclude that the mere utilization of virtual environments is not enough to cover the needs of teachers.

2.2. Holistic Approach: Simple Analysis using Tablets in Class

The conclusions drawn within the project, based on the experiences made in hundreds of European classrooms were that is takes not a specific “very cool and complete” software tool or approach (such as the virtual worlds), it takes a holistic approach that allows combining various data sources used on a daily basis by teachers in their real settings. With respect to virtual worlds, we started to take a different perspective and handed out tablet computers with Wi-Fi connectivity in order to solve the reliability issue. In a first big pilot study, we devised the tablets for tree major activities with 47 primary school students based on Montessori and Freinet pedagogy:

(a) documenting all activities and occurrences in classrooms like the teacher would do manually but, considering the teachers’ limitations, involving learners themselves in that process;

(b) realizing student driven activities like producing videos for the educational contents;
(c) using various learning apps;

Figure 2: Student driven video making in class.

This more complete approach of using technology proved to be more successful and effective than utilizing a single technology, as the technology became part of daily routine for teachers and students. The use of tablet computers in the classroom allowed facilitating the recording and the analysis of data which serves the teachers a basis for formative support and feedback and, at the same time, freeing resources for a more individualized support and teaching. This held particularly true for settings where teachers are required to carry highly detailed activity protocols (such as in Montessori pedagogy). In total, we found that teachers could save over an hour per week and per student. For students it became a motivating factor to engage and develop a constructivist approach. The learning analytics allows for more overview and control over the learning process [10, 11].

3. Learning Analytics in Constructivist Settings

3.1. Statistical Analysis

In addition to the easy and student-supported recording of data, an important value for the teacher is the instant feedback and insights into the individual learning process, provided by smart software services. Teachers' observations and peer reviews and direct activity data are recorded and feed into a generic software app named LIP. The results are instantly displayed in various graphs and diagrams, illustrating the main information.

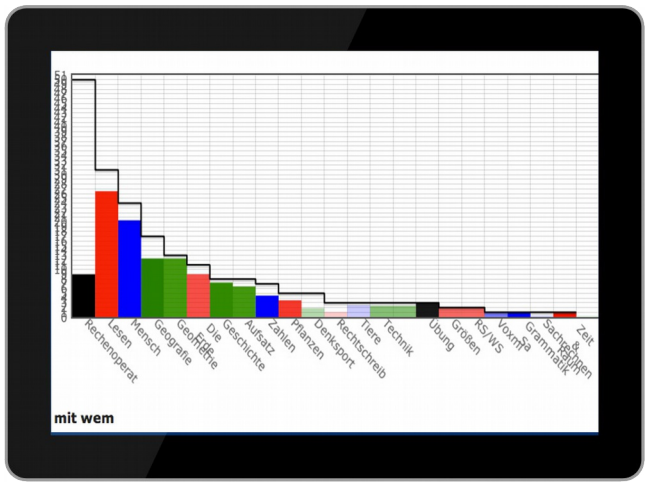

Figure 3: Tablet computer displaying an analysis of learning categories, subjects, and timing

Without this individual analysis (as illustrated in Figure 3) it would be difficult to maintain an overview about what is going on with each individual learning process. Considering

- all the competencies which need to be tracked and
- the very dynamic environment with pupils with 13 different cultural roots coming from a variety of social backgrounds

such an analysis is a prerequisite to allow constructivist learning settings. As some teacher fell the need to maintain a certain level of control what's going on such a diagnostic support is required [12].

3.2. Adaptive Analysis

The statistical analysis could be performed with pen and paper or any spreadsheet application, certainly. However, here we added a knowledge model derived from curricula and competency models. This allows – without changing the collected evidence information – assessing each individual's status and progress in respect of different curricula and competency models.

In addition to that we can reason about observation. e.g. if "A" showed "X" to "B" we can assume that there is a certain likelihood that "A" knows something about "X". If we later observe that "B" is improving his/her skill about "X" we could raise the likelihood about "A" as well.

In the end there occurs a believe model about each student's mastery of certain competencies. It is a probabilistic model to which we assume that "A" is mastering a certain competency. This probability can be explained with observations about evidence shown [13].

For the analysing we are using competency frameworks which are defined by national authorities (e.g., in form of national curricula), national institutions (such as the Austrian BIFIE) [6] and models specific to certain schools (cf. Figure 4).

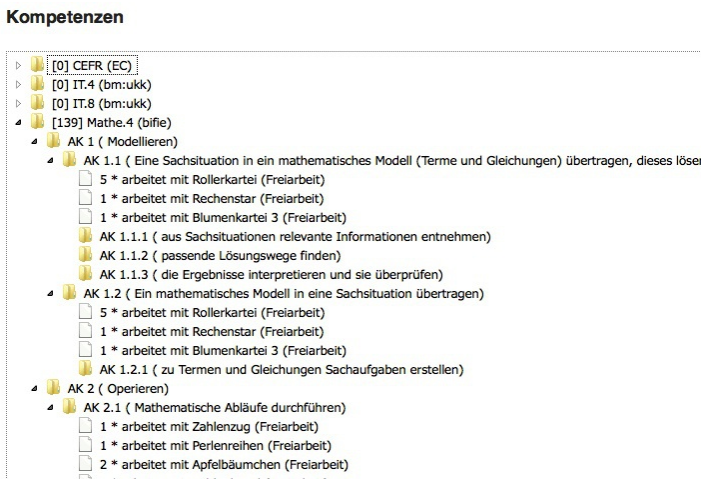

Figure 4: Competencies with explanation based on observation.

Of course, the competencies are not completely independent from each other. If evidence emerges that one competency is mastered those prerequisites can be assumed to be mastered too. There are well-elaborated psycho-pedagogical theoretical frameworks that orbit around such ideas (e.g., [15]).

Assuming a constructivist learning approach, where learners are free to make their own experiences some interesting questions can be answered:

- “what was already introduced to a specific pupil” (e.g. by the teacher; e.g. by another student);
- “on what is a student currently working” (what is interesting to this young person);
- “on what did a student spent how much time” (makes a difference if diagnosing on a specific assessment / test / ... result);
- “what did a student already master?” (where are the strengths, where to go next);
- “with whom is a learner interacting / learning from” (a lot of social insight here);

4. Conclusion and Future Work

Both scenarios, using virtual worlds and using tablets in the physical world, have been integrated an implemented in a broader adaptive analytics framework developed by Next-Tell. In general, we can conclude that the best support for teachers in European classrooms is to take up the technology (in terms of hard and software) they are already using and brining the data together in a central place, enabling a smart and just-in-time analysis. The results must be fed back to teachers in form of intuitively understandable visualization. This allows teachers to support students in an individualized fashion.

Also, from a practical point of view, the integration of technology into daily routines is a key success factor; using sophisticated technology as extraordinary exemption might be cool but not too useful. Still, hurdles such as technical infrastructure, setup costs or backing up, troubleshooting if something fails is critical and oftentimes prevents teachers from taking up broad technologies. Simple and low-cost approaches such as utilizing tablet computers to collect evidence and perform learning analytics turned out to be significantly time-savings for teachers: like 20min every day in documentation savings (no transcription, students help, quicker entries) plus time gained (up to 1h per week) because analysis is calculated automatically by the computer.

To allow for constructivist learning settings it is beneficial, if not a prerequisite, to have proper learning analytics in place. Especially if the audience is as diverse as we can observe it in many Viennese public schools. Otherwise the overview is lost about what every pupil is learning in respect of the significant catalogue of competencies which need to be addressed.

We found, that almost trivial observations, like “who is doing what with whom” are creating useful insights about the individual learning processes. It is bit like the tracking and meta-data analysis of people's mobile phones who can tell a lot about the individual. Now we can bring this kind of analysis to the benefit of the individual learner.

We are confident, that we have found a way how to support diagnostics for teachers and make the learning in schools much more valuable. We are also confident, that we can provide the learner with a map about one's strength and suggestions where to go next in the endless universe of competencies. We want to empower the learner to reflect upon one's own learning process, e.g. to hint for alternative approaches if stuck in a situation.

We believe that looking at evidence in the learning process and thus enabling individual learning processes and support constructionist learning will greatly improve learning in public schools. The challenge we tackled in Next-Tell is to support teachers with smart and innovative technologies, bearing the real world constraints of European classrooms and schools in mind. Solutions with little conceptual and technological demands such as LIP (cf. Figure 3) or the activity tracking platform myClass, developed by the technical University of Graz (cf. http://next-tell.eu/resources/tools/nexttrack/), appeared to be highly beneficial for teachers. Future work will elaborate the developed tools and align them even more to teachers’ concrete needs.

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