InteractiveSchoolWall: A Digitally Enriched Learning Environment for Systemic-Constructive Informal Learning Processes at School

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Abstract: In this article we describe a computer-based novel learning space for teaching and learning at school which digitally extends learning spaces in a new way. We implemented the InteractiveSchoolWall (ISW), a presentation and interaction platform that is publicly accessible in the lobby of a secondary school in Northern Germany. Interactive navigation and self-determined information structuring allow for active learning in an informal way. The pedagogical implications of this presentation and interaction tool are explained with respect to the requirements of Open Learning. The technical construction of the ISW follows the logic of a novel cloud space, which allows the use of personalized and semantically enriched multimedia objects. The ISW consists of an arbitrary number of multi-touch screens running specific applications such as science tools, educational games and semantic modeling systems. We also present an evaluation using log-file analysis and questionnaires for the students of the school to gather information about the use and the affinity for the applications running on the ISW. The results are discussed regarding the further strategy for the ISW. Finally we discuss to what extent the interactive structure of the ISW encourages the reflective handling of complex knowledge.

Introduction

We all live in a world where digital media have gained a powerful influence on people’s lives. However, the acceptance of these new media differs widely. Children and young people have grown up with this new world of computers (digital natives). The enormous technical achievements of the recent past have become part of students’ everyday life and many know how to use them effectively. This is not the case for many older people, among them teachers (digital immigrants). These persons need to learn how to use current technology, which has become much more than a mere extension of traditional office technology. This is not only a matter of technical know-how. These new media represent a basically new form of constructing knowledge and processing reality.

Figure 1: Young teens using the InteractiveSchoolWall.

In this contribution we present a novel and digitally enriched learning space for learning at school, the so called *InteractiveSchoolWall (ISW)* (figure 1). We describe the technical and theoretical context in which the design of a digitally enriched learning environment is embedded. We emphasize the importance of web-based software and the use of personalized, semantic-annotatable media objects. These are considered in the context of systemic-constructive pedagogy, particularly in their role for the co-construction of knowledge, and the assistance in the symbolic organization of certain areas of experience (Holz, 2008). Regarding media theory, the design of the ISW is based on the deep-rooted thought of Marshall McLuhan that media are *"extensions of man"* (McLuhan, 1964).

Our research on innovative learning environments is founded on Design-Based Research (Brown, 1992). According to this approach, theory and real-world usage are conjoined and of equal importance. Thus theory and applications evolve simultaneously during the design process. In such a collaborative design process the implementation of the ISW began in 2010. The applications running on the ISW have been developed by a group of students in media informatics in cooperation with the users in school. The physical construction of the ISW consists of several multi-touch screens with speakers and embedded computers with Internet connectivity, built into a large glass wall in the lobby of the school. This platform provides a place with body- and space-related interfaces and applications that emphasize social and physical activities. It is open and freely accessible for all school-related individuals and offers playful and interdisciplinary, exploratory, collaborative work and learning.

New opportunities for learning with digital technology

In the future, people will communicate through their digitally-enriched physical environment - not only via keyboard and screen, but with their whole bodies. Intelligent spaces, digitally enriched everyday physical objects, mobile devices, as well as body-worn computer systems, such as interactive and intelligent clothing and jewelry will radically change learning spaces. An additional key role is played by the Internet-based connectivity of applications with specifically reference to body and space. In order to produce learning scenarios with this interconnectedness we developed and implemented the so called *Network Environment for Multimedia Objects (NEMO)*. It is a new kind of cloud-based media repository, which enables the user to get access to contextualized, personalized, semantically enriched and device-specific NEMO Multimedia Objects (NMOs) (Winkler, Cassens, Abraham, & Herczeg, 2010). These NMOs are containers for metadata and media objects, which consist of media entities like videos, audio files, texts or 3D objects. These media include meta-information like authorship, access rights, content descriptions, semantic annotations, location data or device-specific information. This data makes the NMOs "richer" than most multimedia data, which allows the inference of dependencies between NMOs or retrieving user and location-related information (Winkler, Scharf, Hahn, & Herczeg, 2011). The digitally enhanced learning environment ISW in combination with NEMO can be a powerful informal space for professional education, playful, and exploratory learning. Most notably, the importance of direct social interaction in groups is promoted. As an exploratory space, the available applications function like a new kind of instrument (apps).

Systemic constructivist pedagogy in the context of a digitally enriched learning environment

Given the rapid changes in our society it is important that students learn to gather knowledge (which is always unique for every individual) from new contexts, and to recognize the underlying knowledge structures. School must evolve to *"allow new educational products such as reconstruction, new construction, and deconstruction of knowledge, to be part of future applications, contexts and situations"* (Kösel, 2007). According to Kösel, knowledge differs from information in this way: information is transformed into personal knowledge through the process of acquisition, judgment and reflection of the viewer in relation to others (for example, through common usage), through contradiction, and through recognition of distinctions; and thus becomes available as a tool for coping with existence. New and different structures of awareness, precipitated by today's new forms of identity representation, media aesthetics and body orientation, must be integrated into a students' *"cognitive toolkit"*. For the mediation process in the sense of an *"organized way of working with knowledge"* it must be asked in what way digitally enriched metaphors allow for a learning culture in which learners are able to construct and communicate knowledge which remains self-determined, socially interactive and rich in connotative references. The didactic potential of digitally enriched learning environments as implemented with the ISW is based on the dynamic knowledge representation which initiates a highly visual, affected, "intelligent" communication and interaction between learners and computer systems. In particular, the exposure to visually represented complexity is essential for the construction of structures of understanding. This culture of learning is motivated and promoted by visualizing the ongoing disciplinary and interdisciplinary debate on "intelligence", i.e. contextualized and in semantic relations. Participation and co-construction of knowledge occurs by the connection between cognition and action due to the appreciation of patterns in which the student learns to ask questions.

The InteractiveSchoolWall and its (current) applications

The ISW serves as a platform for informal learning through presentation and interaction. Groups of learners can structure and arrange information; supported by visual aids. Although, to our knowledge, no systems similar to the ISW exist at school, many applications akin to those found in the ISW have already been developed in other contexts and examined in research. Based on our experience in developing several interactive applications for learning during the last years (Winkler et al, 2008, 2009, 2010, 2011) (Ide, 2013) we argue that body- and space-related digital learning applications at school can only accomplish sustainable enhancement if they are always present and accessible for all students. Our solution to this challenge is based on the idea of a dominant physical user-interface, placed into the social center of the school building. We explain how social co-operation of students can be fostered by placing the InteractiveSchoolWall (ISW) at an important key area at school, on permanent display. The ISW provides new options for co-operative, explorative, informal and game based learning. By means of a multimodal (haptic, acoustic, visual, etc.) and multicodal (text, images, music, etc.) interface students are enabled to interact with the ISW. The design of the ISW supports various body and space-related applications, e.g. Timeline, hypervid, Media Gallery, and Semantic Map (cf. below).

Media Gallery

Contemporary forms and formats of representation of "self" have changed. Young people increasingly communicate and interact via chat and pictures on internet forums. The Media Gallery, in its possibility for presentation of images and videos, represents a surface in which all facets of school life can potentially be reflected upon (figure 2). Divided into content categories such as projects, working groups, study tours, forums, art, music, theater, sports, etc., it provides practically unlimited space and structure to visualize the variety of school life in image and video for students, teachers, parents, and guests. Hence it becomes an important tool for social interaction within the school, which can contribute to identity formation and appreciation. Flexible navigation and content selection allows investigating individual projects that are always expandable. Depending on the priority of specific projects and priorities within the school work, the presence of content on the ISW can be controlled in time, to make an emphasis on the visualization of specific content.

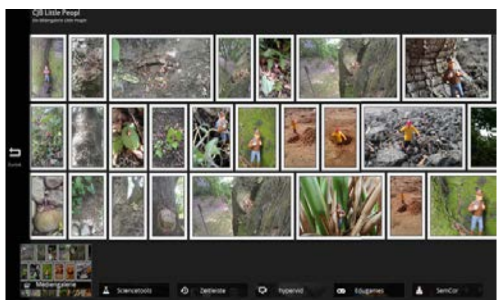

Figure 2: Media Gallery in selection modus showing the student project "Little People".

Educational Games

Educational games (edugames) place learning by playing in the foreground. The edugame "Simon Says" is about remembering sequences of colors and sounds. With every level there comes an additional sound--color-combination and the players have to memorize complex sound patterns. Touching the large color areas with the hands in the correct sequence requires great concentration and physical effort.

The edugame "Numbers" is a math game that focuses on addition. The digits one through nine are represented in a pyramid. At the start of the game, the pyramid has a height of two units. If a level is completed, the height of the pyramid is increased by one unit. The aim of the game is to find a provided sum using the digits of the pyramid. The player is required to make a string of numbers using only one number from each row and starting at the top of the pyramid, while choosing adjacent numbers below. Selected digits are highlighted in yellow and a timer on the right side of the screen counts their remaining time down.

Hypervid Player

Hypervid is a browser-based interactive system for creating, editing, managing and playing hypervideo. Due to time jumps within a video, hypervid enables the understanding of a story in a non-rigid structure. Instead, while watching, the story can be generated within a specific scope. The hyperstructure is reticulate, comparable to associative thinking. The advantage of hyperstructure is that no context-dependent, tree-like classification systems are necessary for systematization or acquisition of terms. The design of hyperstructures implies more than another form of presentation level. It allows to look at interrelated information in networked contexts. The design also hones playful thinking, as its focus is not monocausal solutions in terms of explicability of objects but the potential of navigation of the interaction of the user for a variable set of perspectives. The linked video fragments can be shown by Hypervid Player in a secured browser (figure 3). On the one hand, this blocks the ability for users to leave the resulting hypervideo. On the other hand, it increases the degree of immersion, because the hypervideo does not leave the full picture and the video fragments load dynamically inside the player. Also, hypervid offers the possibility to create groups. Making videos accessible and manipulable for a specific group, groups can communicate with each other. Therefore the systems stay abreast of changes in today's increasingly networked media society and allows for shared learning all over the world.

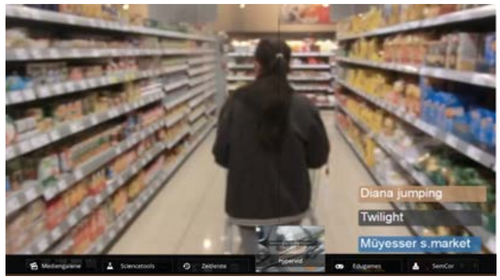

Figure 3: Screenshot of the hypervideo “UNS” running on the Hypervid Player.

Science Tools

In addition to the previously featured applications at ISW, in which the contents were elaborated by school students, there are professional applications with a scientific content ready for interacting. The self-directed exploration of interactive visualizations of scientific content on the touch screens allows playful access to detailed information e.g. the planets of our solar system or 3D visualizations of chemical compounds and molecular structures.

Timeline

The timeline of the ISW can visualize the contents of existing courses at school basically in cross-curricular connections. The design of the timeline tool makes complex relationships comprehensible in an intuitive way. The composition of each timeline is designed dynamically. That means, the timeline interface allows placing content on a specific topic-oriented timeline in a specific way, so that the content and chronological relationships are visible between the different subject areas (figure 6). For the user every single item on the timeline is represented by an icon. An enormous amount of data is hidden behind it, visualized by means of image, text and video. The respective data entries describe information in relation to the time entry, which the viewer may explore by navigating freely. In parallel, contextual linking to other topics, simultaneously a multiple way of looking at things appears, indicating new contents not previously inspected by the viewer. The form of data visualization is essential for the thinking in networked contexts. It helps students to understand specific events in interdisciplinary contexts.

Figure 4: Timeline.

SemCor

The potential of the SemCor can be seen in the possibility to visualize documents with various types of content in their semantic correlation to each other (figure 7). The basis of the interface is that we must act on the assumption of changing organizational forms and ways of thinking in the acquirement of world view, information may no longer be taught sequentially but by fragmentation and linkage (Kuhlen, 1991). By connecting information on similarity principles in meshed complexities, SemCor organizes and visualizes such multiple perspectives on the world (Bush, 1945; Fleischmann, 2001-2010). It illustrates in what context of the whole and the detail a term can stay, which references and links exist to related content, and in which spatial relationships this can be arranged. Thus, the observer finds it easier to navigate through a wider range of topics than in a traditional online search where content is distributed without regard to context in various pages. The fact that the viewer behaves actively using SemCor, individually selecting specific terms, an expanded idea of knowledge as a way of thinking in higher complexities can be promoted.

Figure 7: Screenshot of SemCor.

Evaluation of the use of and affinity for the ISW

Focus of evaluation

Since the target audience of the ISW are students of a specific school it has to be investigated whether the needs of the target audience are met. The evaluation aims at identifying applications that must be changed and at ascertaining whether the system is in fact used. The evaluation is of special importance as students can create content, but cannot create new modules in case of dislike. The first question is which applications are used and, more precisely, how often they are used. A more detailed question is which applications lose popularity when new ones are installed. The second question concerns how much the users like or dislike existing applications. A more profound question is whether the affinity for the applications is stable or not. The affinity for the applications can change due to many reasons. The intention is not to test these causes, but to ensure that the applications meet the users' preferences. Nevertheless some plausible considerations and possible explanations that are relevant for the further strategy of the ISW are given in this contribution. The third question seeks to determine whether a correlation exists between the frequency of use and the rated popularity of an application.

Method

The evaluation has been based on data from two different sources. The use of the applications was recorded by logfiles, which rest on the users' interactive behavior. The affinity for applications is assessed by questionnaires distributed to all students and teachers of the school, which results in a subjective rating by the users. Both kinds of data aim at providing insight in the popularity of the applications. This dual approach compounds the results.

First, log files were recorded which correspond to the frequencies at which each existing application was started. The duration of use etc. is not included. These data reveal, whether the ISW is actually used and how often respective applications are used. The logging started after the installation of the ISW at the end of August 2011. There was an interruption of the logging for 11 weeks due to technical problems (although the ISW was in service) resulting in a gap of recording.

Second, two questionnaires were given to all students of the school. The questionnaires asked for students' affinity for all existing applications using a 7-point Likert scale (ranging from -3 = "very bad" to 3 = "very good"). The students answered questionnaires during class. The first survey for students (t1) was in April 2012, eight months after the launch of the ISW. The second survey was in August 2012 (t2), one year after the ISW had been installed. 769 students were surveyed at the first and 770 at the second measurement; corresponding to response rates of 88.7% and 87.5%, respectively.

Sample

The data of the logfiles cannot be assigned to individuals and result from all persons who have access to the ISW. This includes students, teachers and visitors of the school. However, it can be assumed that the students are principally responsible for the data because they are obviously by far the largest group surveyed.

A sample was gathered from all questionnaires. The student surveys took place in different school years so the population changed as the 13th graders left school and could not participate in the second survey and the 5th graders of the second survey had not yet been at school at the time of the first survey. Of course also students of other grades left or joined the school. Further, students were absent due to different reasons when the surveys took place. For the following analysis all students were included in the sample that reported demographic variables and participated in both surveys, because the comparison of both measures is intended as the absolute stability of affinity is of interest. This resulted in a sample of 300 students, 182 female (60,7%) and 118 male (39,3%). The mean age at t1 was 14.13 (SD=2.27) and ranged from 10 to 19, at t2 mean age was 14.37 (SD=2.22) and ranged from 10 to 20.

Results

The log file analysis shows how often single applications were started. These data were examined in two ways. Firstly, the absolute frequencies of the applications are reported in a longitudinal approach. This represents the use of applications over time. Secondly, relative frequencies across the applications are reported. This is of special interest as new applications are provided. Therefore, the frequencies are examined for the whole period and separately before and after the implementation of new applications.

The use of the existing applications from the end of August 2011 to the end of May 2013 is depicted in Figure 10. The use of the applications is reported in absolute frequencies each application is started per week (Monday to Friday). The gaps which affect all applications are caused by vacations when the users did not attend school. The recording was started when the system ran reliably and users had access to the system. The system started at the end of August 2011 with three applications. In July 2012 new applications, the two edugames, were installed. Figure 10 shows the gap in the records clearly. More gaps caused by holidays and curricular activities outside of school are also visible. The results show that values range between 0 and 1869, and each application is used. The highest absolute value per week is yielded by the Media Gallery, the second highest value by the edugames. Then in descending order the applications Hypervid Player, Timeline and science tools were in demand. The descriptive statistics of use per week is summarized in table 1.

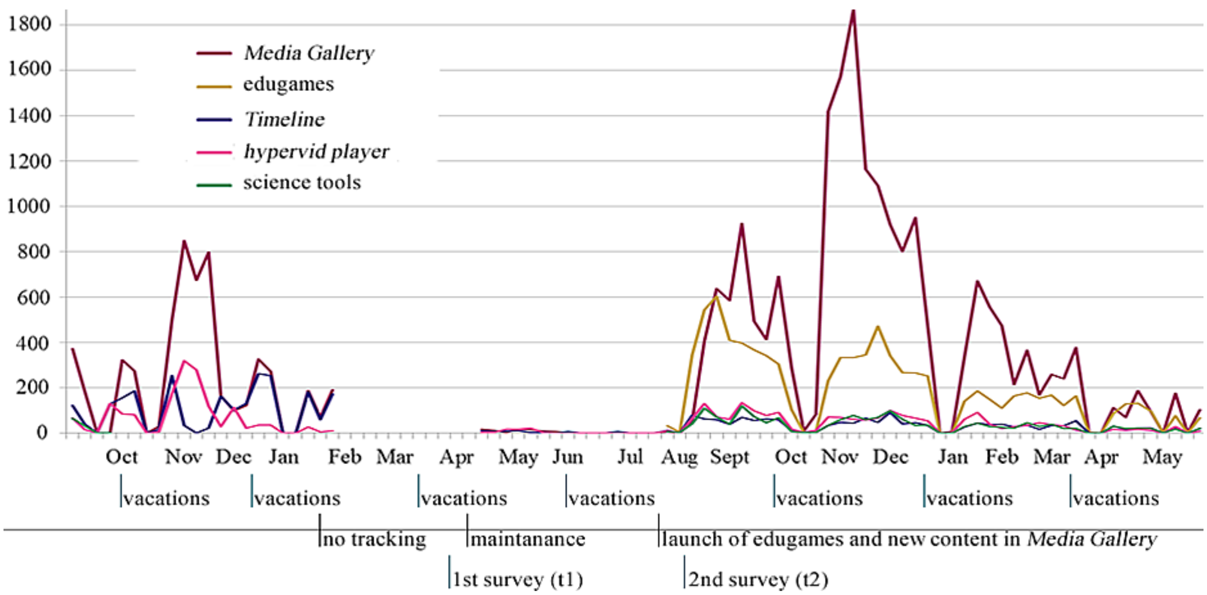

Figure 10: Use of the applications over time - each value represents a week.

Application	minimum	maximum	mean	standard deviation
Media Gallery	0	1869	305.5	398.6
edugames	0	604	191.1	157.2
Hypervid Player	0	320	42.9	57.2
science tools	0	120	34,8	30.0
Timeline	0	262	46.2	61.4

Table 1: Use of the applications per week – descriptive statistics.

The second approach focuses on the relative frequencies of visits. Therefore, the frequencies of different periods are compared. The respective periods are the whole period for which data are available, the period before and after the installation of new applications in August 2012. The comparison of the last two periods shows potential effects of the launch of these applications.

Inspecting the whole period, 59% of all visits of applications are allotted to the Media Gallery. It is followed by the two applications that constitute the edugames with 20%, the Timeline (9%), the Hypervid

Player (8%) and the science tools Planetarium and Molecule Viewer (4%). Thus currently the Media Gallery shows the highest popularity of existing applications judged by its hits.

In order to account for the effects of the installation of the edugames, the relative frequencies for the periods before and after the end of July 2012 are calculated, when the edugames were installed. The relative frequencies differentiated by periods are reported in parts b and c of figure 11. Before the launch of new applications, the Media Gallery again has 59%, the Timeline has 24% of visits and the Hypervid Player is third with 16%. The science tools have a very small proportion of 2%. After the launch, the distribution of visits as well as the sequence of frequencies is different. The Media Gallery is still the most requested application with a stable proportion of 59%. The second largest proportion is no longer held by Timeline, but by the edugames (26%). The last three types of applications have similar results (Hypervid Player 6%, science tools 5% and Timeline 4%). The main finding is that the installation of the edugames decreased the relative frequencies of the Timeline and Hypervid Player, whereas the visits of the Media Gallery remained stable. The use of the Timeline in the first period is 24% and decreased to 4% in the second period. The edugames Simon Says and Numbers evolve to become the second most frequently demanded applications. The Hypervid Player also lost visits due to the launch of new applications. The Media Gallery is the most requested application in all inspected periods and the new applications had no effect on its proportion of visits in the inspected period. The proportions of all other applications (except the science tools) decreased as the edugames were installed. Possible explanations for these changes will be discussed below.

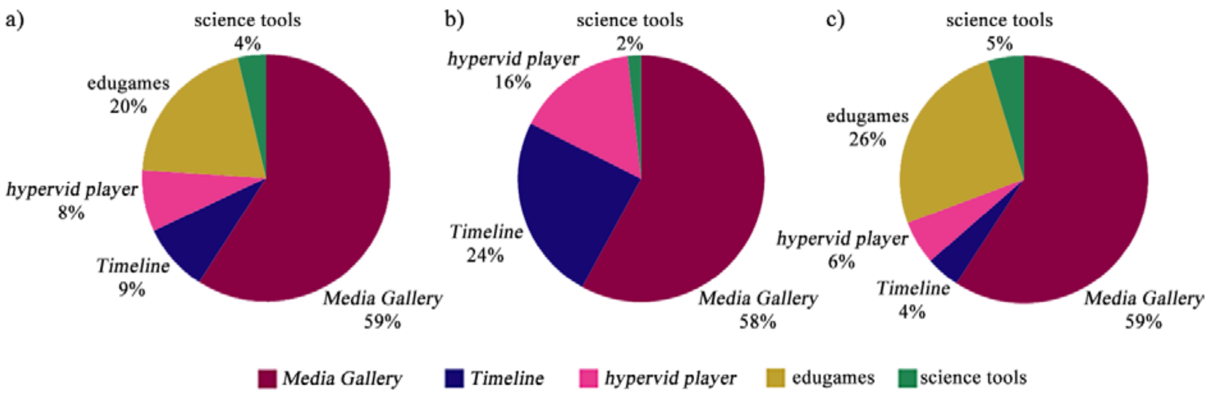

Figure 11: Relative frequencies of visits (a) for the whole period, (b) before, and (c) after the installation of the edugames.

The means of affinity for the applications are tested for statistical significance for the applications that existed at the time of both surveys. This represents the absolute stability of affinity. The descriptive statistics of the remaining applications are also reported. The comparisons are conducted for students' questionnaire data. The means and standard deviations for the applications reported by students are reported in table 2. The results show that students rated their affinity for Media Gallery ($t(208)=0.091$, ns), Hypervid Player ($t(191)=0.204$, ns), Planetarium ($t(185)=1.757$, ns) and Molecule Viewer ($t(184)=0.973$, ns) equally at the time of both surveys. There was a significant difference in the affinity for the Timeline ($t(223)=2.748$, $p<.01$) as students rated their affinity lower at t2. Thus regarding the absolute stability, the affinity for Media Gallery, Planetarium, Hypervid Player and Molecule Viewer did not change between both measures, whereas the affinity for the Timeline decreased.

application	mean (standard deviation)		
	t1	t2	N
Media Gallery	0.34 (1.54)	0.33 (1.44)	209
edugame : *Simon Says*	-	0.31 (1.75)	216
edugame: *Numbers*	-	0.13 (1.75)	220
Hypervid Player	-0.38 (1.48)	-0.41 (1.38)	192
science tool: *Planetarium*	0.60 (1.73)	0.39 (1.65)	186
science tool: *Molecule Viewer*	0.55 (1.80)	0.42 (1.65)	185
Timeline	0.74 (1.42)	0.46 (1.34)	224

Table 2: Means and standard deviations of students' affinity for the applications.

The last question this evaluation seeks to address is whether the use of the applications and the affinity for the applications correspond to form a coherent picture of usage. Therefore, the affinity ratings and the relative frequencies of use for the applications were interrelated at the time when the surveys took place. Thus the points in time correspond and the data refer to the same period respectively. The advantage of this inspection is that the popularity of the applications is operationalized by two different measures that rest on usage behavior and or reflect subjective ratings which can produce more or less corresponding pictures.

The relative frequencies for the applications are recalculated for the periods from the installation of the ISW to the date of the students' surveys. These periods differ for 118 days. The data are reported in figure 12. The relative frequencies from the beginning to t1 are in accordance with the frequencies before the launch of new applications. The duration of these periods differs for 99 days. The relative frequencies at t2 resulted in another picture. The Media Gallery still drew more than half of the visits (54%), but did not attain the former 59%. The Timeline still had the second highest proportion (23%), followed by the Hypervid Player (15%). The newly launched edugames Simon Says and Numbers (5%) and science tools Planetarium and Molecule Viewer (2%) claimed 8% of visits that were at the expense of the Media Gallery and Timeline. At t2 the edugames had only been available for 19 days, thus the lower proportions (compared to the whole period, see above) are not surprising.

The affinity ratings are also recalculated with all available data (see table 3) in order to increase the potential correspondence. The analysis of absolute stability resulted in absolute stability of all applications with the exception of the Timeline. Table 3 shows that the Media Gallery did not yield the highest affinity ratings, although it was used most often. The correspondence between the affinity and the use of the applications is determined by its correlation between the means and relative frequencies at t1 and t2. The correlations between mean affinity ratings and logfile data were not significant ($r_{t1} = -.14$, ns and $r_{t2} = -.18$, ns) indicating that on this level no relationship between affinity and use of the applications existed. Thus the affinity ratings and the use of the applications were not consistent with each other in both surveys.

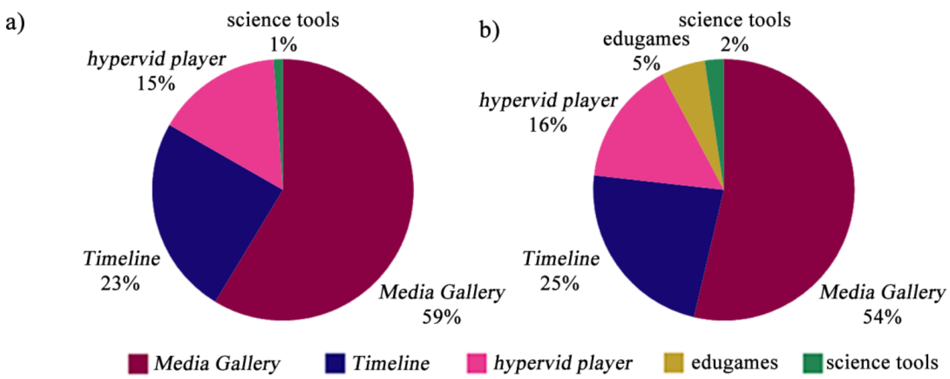

Figure 12: Relative frequencies of visits (a) from the beginning to t1 and (b) from the beginning to t2.

application	mean (standard deviation)	relative frequency	mean (standard deviation)	relative frequency
	t1		t2	
Media Gallery	.20 (1.52)	59%	.22 (1.46)	54%
edugame: *Simon Says*	-	-	.43 (1.73)	5%
edugame: *Numbers*	-		.36 (1.74)	
Hypervid Player	- .41 (1.54)	16%	- .39 (1.42)	15%
science tool: *Planetarium*	.45 (1.75)	*1%	.36 (1.56)	2%
science tool: *Molecule Viewer*	.49 (1.83)	-	.31 (1.61)	
Timeline	.68 (1.56)	25%	.43 (1.43)	23%

Table 3: Relative frequencies and descriptive statistics for all available data.
*replacement of Phases of the Moon by Planetarium, N = 495 to 604.

Discussion

An important circumstance of this evaluation is that the system is located on the field. This means that the setting is not controlled as in an experiment. Moreover it is not possible to vary applications and content systematically to investigate effects, because the system is in daily use at school. This constrains permitted interpretations.

The log file analysis showed that the system is used, as well as all of its applications. The launch of the edugames had effects on the relative frequencies of the applications. The proportion of the Timeline strongly decreased (from 24% to 4%). This might be explained by the fact, that very little new content has been uploaded in the respective period, while the Media Gallery constantly received new content. The Hypervid Player lost substantial parts of its proportion too, and again, very little new content has been uploaded. Thus the offer by this application did not change or grow and the application was started less often. The newly launched edugames yielded a proportion of a quarter and were the second most frequently demanded applications. This indicates that the installation of the edugames was a successful decision and the applications were used. The science tools' proportion increased from 2% to 5%. The low proportion in the first period can (in part) be attributed to its removal because of security problems. One application was substituted by another application addressing a similar topic. This substitution took place in the gap of recording logfiles. Nevertheless, the science tools are the least demanded applications regarding the whole period. The Media Gallery was not affected by the launch and is the strongest demanded application of the system. This can be explained by the enormous amount of content that was added in autumn 2012, that took place simultaneously with the increase of use. Therefore, we assume that the use of applications was also dependent on the amount of content that was added. A systematic variation was not possible.

The analysis of data of the students' affinity for the applications was derived from questionnaire data. They showed that the affinity for Hypervid Player, Media Gallery, Planetarium and Molecule Viewer did not change over a period of 4 months. This indicates absolute stability in their attractiveness for this period. The Timeline is an exception as its affinity rating decreased. This is seen as a negative development that has to be considered for future strategies. As a consequence of this finding the creation of new content in the application Timeline will be enforced.

The third question addressing the correspondence of the use of the applications and the affinity for the applications showed that both indicators of popularity did not correlate. Thus use and subjective rating of the evaluations might be influenced by different factors. A further question for future investigation is the development of affinity for the applications over a long-term period and in relation to students' age.

As a result of the evaluation, current changes focus on the expansion of the context of the Timeline, hypervid and the new application SemCor in formal learning situations in the classroom. The results of the lessons will enrich the content offered by the applications of the ISW. In order to enforce new content – especially for the Timeline – the graphical user interface will be revised to facilitate the input of information and media. There are also plans to investigate further involvement of students into content creation. It is envisaged that students create content more independently and that they can immediately react to the setting of content visible to all. Thus they might identify more strongly with the applications of the ISW and use them more often.

Conclusions

Processes of teaching and learning, which are generally open and not constricted by linear models of mediation open up spaces for independent learning and various forms of appropriation of knowledge. This thinking highlights that learners can only learn by themselves. But it is necessary to create motivational opportunities for self-directed learning and reflexive use of complex knowledge. In this context, the ISW extends the existing learning environment in school with an important didactic function: it represents diverse perceptions and scripts by the learners to acquire a perspective on their world in such a way, that the appropriation and self-learning potential can be strengthened. In its non-hierarchical structure, the ISW provides a new architecture for knowledge construction. It does not meet the conventional structures of learning, but expands them.

The ISW applications, e.g. hypervid (Winkler et al., 2011), are developed on the basis of ongoing evaluation in a way that shows how this learning space digitally extends learning spaces at school in a new way. Due to the central authentification, usage of the same semantically annotated multi-media in a variety of applications via NEMO (i.e. media created with the Mobile Learning Exploration System (MoLES) (Winkler, 2013) and the ability to be placed into semantic correlation to media of the Semantic Web (i.e. DBPedia) with SemCor, learners can develop trans-disciplinary and cross-curricular competencies. Interactive navigation and self-determined structuring, through the production of content and its publication using the ISW, allow active learning in an informal manner, where students are engaged in the presentation and exchange of views.

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