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DIYLab as a way for Student Teachers to Understand a Learning Process

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Abstract. The authors introduce their experiences gained in the EU project *Do It Yourself in Education: Expanding digital literacy to foster student agency and collaborative learning* (DIYLAB). The project was aimed to design an educational procedure based on DIY philosophy with a student-centred and heuristic approach to learning focused on digital literacy development and later to verify it in teaching practice in primary and secondary schools and HEIs in Finland, Spain and the Czech Republic. In the Czech Republic the project DIYLAB was realized as a teaching approach in initial teacher education with Bachelor and MA degrees for ICT, Biology, Primary Education and Art Education student teachers. DIYLab activities represented occasions for student teachers to bring interesting problems related to their study programmes and also their after-school interests. An integral part of DIYLab activities was problem visualisation using digital technology; visual, film, animation, etc. served as a basis for assessing both pupils' digital competence and their problem-solving capability. The DIYLab have influenced student teachers' pedagogical thinking of how to develop pupils' digital literacy and to assess digital literacy development as a process and not as a digital artefact. Following the project, the DIYLab approach is being included in future Bachelor and MA level initial teacher education with the aim to teach student teachers (1) to design DIY activities for digital literacy development supported inter-disciplinary relations in school education, and (2) to use digital technology to oversee and assess learning as a process.

Keywords: Digital Literacy, DIY, DIYLab Activity, Visualisation of Learning Process, Student Teacher.

1. Introduction

Since 2006, ICT has been included in the curriculum as compulsory for primary, lower and upper secondary education in the Czech Republic with the aim of developing digital literacy and the use of ICT skills so that pupils are enabled to use standard ICT technology. In schools there is, however, a tendency for ICT lessons to focus on outcomes which can be produced by basic formats using a typical office

suite (for example, using a word processor, spreadsheet and presentation program) and on the ability to search and to process information (primarily via the Internet).

Some pupils and HEI students manifest their discontentment against how digital technology is used in schools. They show teachers they are more experienced in using digital technology than their teachers. The 2006 ICT curriculum is a thing of the past. It does not sufficiently reflect new and advanced technology and the need to implement innovative teaching approaches in digital literacy development which emphasises the educational potential for new ways and strategies of learning, not just user skills.

Thus the Czech government approved in 2014 the Strategy of Digital Education ([9]) that would contribute, among other things (1) to create conditions for the development of the digital literacy and computational thinking of pupils, and (2) to create conditions for the development of the digital literacy and teachers' computational thinking.

The DIYLab, being grounded in DIY (do-it-yourself) philosophy, is an example of an innovative approach to education which worked in schools and enabled the development of digital literacy. Pupils at all levels were at first cautious but attracted to the idea and motivated to learn. Teachers were empowered by coming to understand another strategy to enable students' learning.

2. The DIY Concept

The concept of DIY is not totally new. It can be found when speaking of the development, for example, of amateur radio as a hobby. The DIY movement has developed and spread step by step into different branches (technical education, Art, science, etc.). It has common features: it brings together enthusiastic people (who have the same aim and interest) to solve in a creative way interesting problems in their field and mutually to share "manuals" on how to proceed or how "you can do it yourself".

Globally, there is a generation of DIY enthusiasts and supporters who join in various communities or networks. There is nothing that could limit activities of this generation of creative and thoughtful people; if they need to know something to be able to realise their DIY ideas they learn from one another. The DIY generation very often uses ICT for their creative initiatives. The DIY generation visualises stories to document the process explaining how problems were solved to be shared as tutorials by others. Freedom to make and to create using ICT is perceived as freedom of access, in the choice of tools and technology, and a release from reliance on specific software and hardware tools; it is using a variety of resources, making copies and sharing outcomes and methods.

3. Implementation of DIY into Education

To apply DIY in schools means enabling pupils to bring into school interesting ideas from the extra-curricular environment and to create conditions for their exploration; to put them within a school curriculum and to (re)arrange circumstances for

collaboration and sharing experiences, in a similar way to that in which scientists and experts might work. Through such processes pupils can use their knowledge and skills from different subjects and interests so they can keep discovering new things and interdisciplinary contexts and connections ([10]). In such activities pupils organise themselves, their procedures and processes; principles of autonomous learning are thus being put into practice.

According to Y. Kafai and K. Peppler ([5]), it is possible to incorporate DIY activities into programming, designing models, constructing robots, creating manuals (tutorials) on how to do or how to learn something (for example, how to count using an abacus). Thus, DIY can potentially contribute to further mastery in the use of digital technology and consequently improve digital literacy. DIY in school contexts corresponds with the concept of learning as "the natural, unstoppable process of acquiring knowledge and mastery" and being aware that "the vast majority of the learning in your life doesn't happen when you're a kid in school" ([6, p. 22]).

This article focuses on DIYLab activities implemented through the project DIYLab in teacher education at the Faculty of Education but also includes an example from a school since one of the participant teachers was also a student teacher at the Faculty.

First, it was necessary to map ideas of student teachers and teacher educators *if, why and how* to bring topics from outside students' activities into their study programme. The student teachers were expected to integrate their own interesting problem related to their life or hobbies, but unfortunately the majority of them did not come with any own initiative waiting for a task formulated by their teachers. It emerged that student teachers who participated in DIYLab had not been used to bringing their extra-curricular interests, hobbies, or expertise into university study. After that, it was necessary to specify a framework and key features of the DIY activities which were consequently realised by student teachers.

4. A Model of DIYLab Activity

Imperative in the practice of DIYLab is that all who apply the DIY idea in their activities endeavour **to share with the outside world how they proceeded and how they solved a problem**. They develop tutorials which visually (using movie, animation, etc.) document the process, explaining how problems were solved and what was learned. This means of transmitting to others how to proceed may be perceived as an author's self-reflection of his/her learning. Story-telling - a narrative assemblage - is a very important attribute of the DIY creation process ([4, p. 300]). The publishing of a procedure or a manual on how to create or produce something or how something was made can help others to produce something similar; it can help others to learn new methods or to create something completely new and original. The concept of DIY aligns with young people's experiences who point out that in schools "we miss so much of the richness of real learning, which relies on failure, trial and error, getting to know people, and reaching for things you didn't think were possible" ([6, p. 75]).

4.1 Key features of DIYLab activities

A model of DIYLab activities was based on DIY philosophy which is a student-centred, heuristic approach to learning and problem-solving and which implies six pedagogical principles for approaches to learning (Table 1). A key aim of DIY activities beyond solving a problem is to provide a manual on how to solve the problem. This "handbook" is then published in a form which can be shared with others – the best and easy to understand way is in a visible form (e.g., video, animation).

Table 1. Six pedagogical principles for a design of DIYLab activities

Feature of DIYlab activity	Idea	Authors, resources
(1) to support collaborative learning	Members of DIY communities collaborate mutually.	
(2) to have the characteristics of inquiry-based teaching and learning methods	DIY communities dedicate their time to original problems which have not been solved and which are different to traditional school tasks.	
(3) to support trans-disciplinary knowledge	To enable pupils to bring into school interesting ideas from the extra-curricular environment and to create conditions for their exploration. If pupils have an interesting problem to be solved, they do not worry about which school subject it relates to.	J. Sancho et al. ([10])
(4) to contribute to autonomous / self-regulated learning	Documenting how to proceed for others may be perceived as an author's self-reflection of his/her learning. DIY communities enjoy to find a solution "Building new tools and paths to help all of us learn".	K. M. Jocson ([4, p. 300]) A. Kamenetz et al. ([6, p. 20])
(5) to contribute to digital literacy improvement	"DIY youth voluntarily spend a lot of time in intense learning, they tackle highly technical practices, including film editing, robotics, and writing novels among a host of other activities across various DIY networks." To develop *photo-visual digital thinking skill* as a component of digital literacy	Y. Kafai, K. Peppler, ([5]) Y. Eshet-Alkalai, ([3, p. 93])
(6) to be connected with the curriculum	School curriculum / study program for HEI students	

The requirement to visualise a learning process about "how the problem can be solved" as a message for others follows several reasons. Firstly, visual tools are normally understood as comprehensible regardless of which languages we speak. Secondly, we are all, student teachers included, increasingly surrounded by visual stories (e.g. YouTube, animated instructions for passengers how to behave during a flight). The skills required to use digital technology for visualisation fully correspond to a concept of digital literacy defined by Y. Eshet-Alkalai ([3, p. 93]): "digital literacy involves more than the mere ability to use software or operate a digital device; it includes a large variety of complex cognitive, motor, sociological, and

emotional skills, which users need in order to function effectively in digital environments." Eshet-Alkalai's conceptual model of digital literacy consists of five digital literacy thinking skills, including the "*photo-visual digital thinking skill*: Modern graphic based digital environments require scholars to employ cognitive skills of "using vision to think" in order to create photo-visual communication with the environment. This unique form of digital thinking skill helps users to intuitively "read" and understand instructions and messages that are presented in a visual-graphical form, as in user interfaces and in children's computer games." ([3, p. 93])

5. Specification of a Research Field

The implementation of the DIYLab project in teacher education was an opportunity to focus on the development of pedagogical thinking in student teachers; primarily to enrich by using an innovative didactical approach to digital literacy development, and to understand better the learning process.

The project DIYLab was expected to answer questions such as *how much* student teachers are capable of visualising their learning, *which type of visual description* (narration) student teachers would produce or *how difficult* it is for them to visualise their learning process. The student teachers had not been used to considering why and how to visualise the learning process. They had studied learning theory in aspects of pedagogy and psychology. Therefore, it was expected that they would find visualising their learning processes challenging because they had never undertaken such a pedagogical task. During their HEI study, they mainly do self-reflections from didactic situations, teaching processes or learning only in oral or written forms, but not in a visual manner.

5.1 Research Methodology

Participatory Action Research - PAR ([1]; ([7]; [8]) was the research methodology adopted since it allowed active engagement, intervention and the opportunity for participant observation. The approach was also consonant with the democratic values implicit in the above-stated DIY philosophy. The impact of DIY approach on teacher education was studied using qualitative research methods (focus groups, questionnaire surveys, interviews, observations and analyses of student teachers' DIY outcomes). Teacher educators evaluated not only the *originality* of student teachers' DIYLab activity procedures, but also how much these DIY activities corresponded to *the six pedagogical principles* (see Fig. 1) and to what extent student teachers managed *to visualise a process* and their ways of thinking and learning.

5.2 Characteristics of student teachers participated in DIYLab activities

From January 2015 to January 2016, at the Faculty of Education, 192 part-time and full-time student teachers (aged at least 20 years) and eight teacher educators from four departments (IT and Technical Education, Art Education, Biology and Environmental Studies, and Primary Education) were introduced to the DIY philosophy within compulsory courses focused on pedagogy, ICT education, computing education, biology, educational technology, multimedia etc.

6. Analysis of Some DIYLab Activities Performed by Student Teachers

The student teachers worked on 16 themes for DIYLab activities and produced within one semestre 81 digital outcomes of different quality and content: *Multimedia project* (6 DIY digital objects/ 11 students), *Design of Android applications* (4/11), *Little dances with Scratch* (4/12), *Collection of examples of problems which human cannot solve without using computer* (6/28*), Contemporary trends in WWW pages development* (5/9), *Teaching learning object development* (4/12), *Wiki of teaching activities* (1/8), *Educational robotics project* (6/16), *Anatomy and morphology of plants* (5/20), *Biological and geological technology - field trips* (2/3), *How I´m becoming a teacher* (17/23), *Animated stories* (11/13), and *Teaching with tablets* (10/26). Some of them were published on the HUB (hub.diylab.eu).

6.1 Ways in which the DIYLab activities met the defined requirements

(1) Collaborative learning

The collaborative approach to DIYLab activities was the most irregular one, and was dependent on each particular process and students. For the part-time student teachers who live and work in different places of the Czech Republic and only meet during classes at the Faculty of Education collaboration and co-operation with their co-scholars are more fitting and appropriate than for full-time students. Some DIYLab activities were extremely specialised and tasks had to be solved individually.

(2) Inquiry-based teaching and learning

DIYLab activities were not for student teachers routine tasks usually assigned in seminars. In some cases, the student teachers faced technological problems (see *Building android apps* or the specific solution for *Installing a camera in a birdhouse* for the subject Multimedia Systems), in another cases they faced more theoretical didactic problems (see *Collection of examples of problems which human cannot solve without using computer*).

(3) Trans-disciplinary knowledge

Almost all of DIYLab activities had trans-disciplinary overlap. In some cases, the trans-disciplinary co-operation became obvious only thanks to the DIYLab project and had an impact in forming a student teachers' professional competence of self-reflection (e.g. *How I'm becoming a teacher*). Nearly thirty per cent (28.5%) of ICT student teachers stated that in their DIYLab activity they did not use knowledge from other subjects; if there was any required knowledge from other subjects, it was mostly from physics, mathematics, English, geography, medicine or cinematography or computer science, and rarely from biology, chemistry or art. Nevertheless, they appreciated the opportunity to collaborate with students of other study specialisations very much, and due to such collaboration from their point of view they learned a great deal.

(4) Autonomous / Self-regulated learning

The dimensions of independent learning and self-regulation underpin the whole process and were actively promoted, taking due account of the diversity of the students and their willingness to learn by new means. The student teachers appreciated the DIYLab approach to learning from two perspectives: they learned (a) another approach to solve an issue, and (b) how to properly lay out their work, to visualise and organise tasks in order to find solutions.

(5) Digital literacy improvement / Digital competence

In carrying out the DIYLab activities the student teachers worked with quite a narrow range of hardware and software which was largely determined by the technical equipment available at the Faculty of Education or in the resources available through their respective Bachelor's and Master's degree studies. Most of the student teachers involved in DIYLab activities were ICT students. In general, in the case of ICT student teachers it was virtually impossible to determine any improvement or progress in their digital literacy. Based on the outputs, the students were mostly using video, presentation and text editors. For ICT student teachers, the majority of DIY activities were only an opportunity (sometimes a routine) to apply their digital literacy skills to solving problems, while for Art or Biology Education student teachers DIY activities distinctively contributed to improvement of their skills in using digital technology. As a result of involvement in DIYLab they learned to create animations etc. DIY activities with ICT student teachers increased their didactic thinking about the role and possibilities of digital technology in education; besides that, they assisted their Art Education peers to be able to do animations or Biology student teachers to design a technological solution and to install a camera in a birdhouse.

(6) Connection to study programmes / curriculum

The student teachers did their DIYLab activities during one semester as a part of their final work with the aim of gaining credits and grades. Each DIYLab outcome consisted of two main parts: (i) a product as a solution of the problem (e.g., SW application, a set of 3D tools, models, database, mechanical drawing, electric circuit, robot), and (ii) a digital object (e.g. video, movie, animation) which visualises a process demonstrating how student teachers were progressing, how they learned a problem and how they managed to resolve a DIYLab activity.

Fig. 1 shows the results of a questionnaire survey focused on how teacher educators evaluated their DIYLab activities connecting the six pedagogical principles. From this evaluation the following average values for each item are derived: contribution to autonomous / self-regulated learning (4.8), digital competence improvement (4.4), connection with the curriculum (4.3), support to trans-disciplinary knowledge (3.9), inquiry-based teaching and learning (3.6), and support for collaborative learning (3.1).

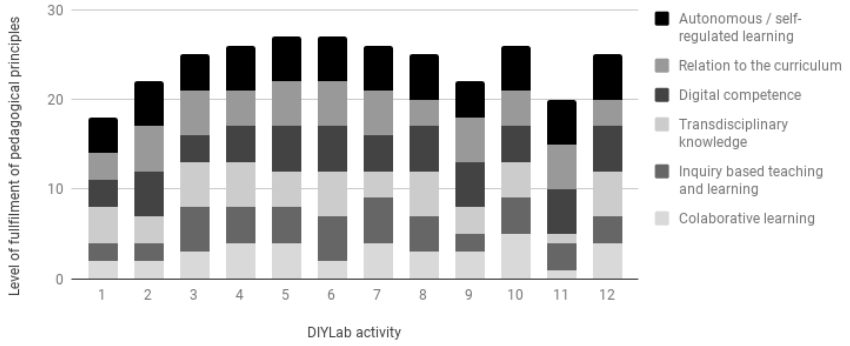

Fig. 1. Teacher educator's evaluation of their DIYLab activities using a scale 0-5 with 0-being no accomplishment and 5-being maximal accomplishment. (Source: [2])

The majority of problems solved in DIYLab were not characteristic of inquiry-based problems. Teacher educators invested a lot of time facilitating student teachers to develop a DIYLab idea. For the teacher educators it was not always easy to motivate their students to bring their own projects. Students seemed to be afraid to step into new territory. The main motivation to carry out their DIY activities for some student teachers lay in getting credits, not in solving problems. In part-time study, there was not much time for defining and understanding a problem for inquiry-based teaching and inter-disciplinary links. Potentially, this is an advantage since it may have contributed to increased online collaboration between students and an increase in collaborative learning. There were several factors (teacher educator, student, solved problem, study specialisation, motivation, experiences, etc.) that influenced a way how particular pedagogical principles were accomplished in each individual DIYLab activity (Fig. 1).

6.2 Examples of DIYLab activities carried out by Bc degree student teachers

The student teachers on ICT Bachelor Studies' courses counted on their teachers to assign them a topic. Despite some of them work in computer companies or specialise in some aspect of computing, they rarely came up with their own proposals. When they had some ideas for topics for DIYLab activities these were related to their hobbies (e.g. diving, gardening, theatre). Some of them were surprised that they had to do something linking knowledge and experiences from different branches or disciplines.

For example, there was a student who was interested in scuba diving and who proposed a project, *Diver's LogBook* (see http://hub.diylab.eu/2016/01/27/divers-logbook/). Another student is part of a theatre group, Kašpárek and Jitřenka, and she decided to initiate a project entitled, *Database Development – database of theatre ensembles* (http://hub.diylab.eu/2016/01/27/database-development-database-of-theatre- ensembles/). Bc. student teachers of Biology who studied the life of birds in a nesting box directed their activities to a project, *Bird House*

(http://hub.diylab.eu/2016/01/27/bird-house/). In courses focused on digital technology, one ICT student looked for a solution as to *How to create an animated popup message in Adobe After Effects.*

Bachelor student teachers weren't used to thinking about *what* and *how* they had learned, much less *how* to visualise their own learning process. They didn't consider thinking about learning and reflection on DIYLab activity to be "professional". Unlike Art Education students, the ICT student teachers are advanced in digital technology, but they lack knowledge and skills to observe and to visually display and present processes. Bachelor ICT student teachers very often reduced a visualisation of their DIYLab procedure to a set of screenshots. They recognised DIYLab only from the technological point of view and the extent to which software and hardware were applied. Generally, for Bc. student teachers it was very difficult to visualise their learning in DIY activities. They were not particularly interested in the pedagogical concept of learning and how to visualise its process because in Bc. study programmes the main focus is on acquiring knowledge from particular branches (Biology, ICT, Art, etc.), rather than understanding the learning process involved.

6.3 Examples of DIY activities carried out by MA degree student teachers

The MA degree student teachers did their DIYLab activities predominantly within didactic subjects or courses making limited use of technology. The majority of them were part-time students who work in schools as unqualified teachers of ICT or Informatics subjects, and so most of them tried to apply the DIYLab idea in their teaching with their pupils.

MA student teachers thought about and mediated the topics and the purpose of DIYLab activities more deeply than Bachelor-level students mainly due to the fact that they realised their DIYLab activities primarily in courses focused on didactics' aspects and contexts. MA student teachers elaborated some general themes proposed by their teacher educators.

The requirement to record and visualise a learning process did not surprise MA student teachers. They understand how important it is to visualise a learning process from a pedagogical point of view. Data taken from such visualisation can help teachers to understand better the learning outcomes of their pupils. However, they had no experience in the process of visualisation. Similarly to the Bachelor-level students, they very often reduced a visualisation of DIYLab procedure to a set of screenshots. A few of them did an animation of their way of thinking about the DIYLab activity. (e.g., *Problems which a human cannot solve without using a computer – tomography*). Some of them did a tutorial (*An animated story about a small wizard*, https://www.youtube.com/watch?v=QA1skX4GiBI). Some of them developed a methodical guide how to work with pupils (*DIY_Little Dances in Scratch – Start to move_CZ*, http://hub.diylab.eu/2016/01/11/little-dances-in-scratch-start-to-move/diy_little-dances-in-scratch-start-to-move_cz/), some did a comic strip.

6.4 Examples of DIY activities carried out by pupils and completed in lessons managed by ICT student teachers on school practice

Some part-time ICT student teachers decided to apply DIYLab to their class teaching in schools where their pupils did similar DIY activities. All these experiences from

schools demonstrate a great enthusiasm and motivation to learn and to solve problems related to after-school activities and through which they develop their digital literacy.

For example a girl (aged 15) enjoys recording and editing digital sounds in her free time. She designed a DIYLab activity as a sound story-telling of a boy who would like to meet his girlfriend (https://www.youtube.com/watch?v=a8TzZCAzxKo). She describes how she produced the story-telling as a movie in which she explains what she did, how she collected sounds and which software applications were used in her work (https://www.youtube.com/watch?v=jbSID9_B72k).

7. Conclusions

Although the EU project has now ended, the Faculty of Education will continue DIYLab activities as a compulsory assignment and an integrated component on courses for Bachelor degree ICT study and for full-time and part-time student teacher of MA degree ICT study. Great attention will be given to (i) ways how to motivate student teachers to choose appropriate topics from their after-school interests and hobbies and to design DIY activities for inquiry-based learning, (ii) methodological approaches as to how to visualise a process of learning in Informatics, Computing or ICT subjects; diaries, scenarios, process-folios or log books used in Art Education or in technical or technological oriented branches will be used as an inspiration for such an approach in ICT teacher education, and (iii) how to support a close interdisciplinary collaboration among student teachers and teacher educators.

The challenge for the Czech context is to change the culture from teacher-dependency to students as independent, autonomous learners in the classroom. Creativity in content, methods and pedagogy are absolute requirements to achieve this goal. The DIYlab project showed differences and limits in the culture of approaches to creativity from a pedagogical point of view: If we compare the DIY learning in educational practice in Prague with approaches to creative learning in Barcelona, which is a popular place for international creative artists and DIY communities, in the Czech context the DIYLab will need much longer to break free from the bureaucratic concept of teaching and the assessment of learning outcomes.

The value of the evaluative criteria in framing the DIY process and the parameters used enabled analysis and could support the design and thinking by teachers considering using the DIY method.

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