



D7.3 DIDY-RELATED EDUCATION PROCESSES

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Executive summary

Deliverable D7.3, DIDIY-related educational processes, presents a set of broad lines for education stakeholders. By exploiting synergies coming from different investigation environments, its aim is to make DiDIY impacting more effectively on society at large. The present deliverable is the final output of Task 7.3. DiDIY-related education processes and the overall WP7 “Integrative modelling, guidelines and tools for the transferability of results”. It leverages on the conclusions arising from D4.4, Results derived from data collection and analysis, and D4.5, Strategic plan, aiming at the definition of appropriate strategies to reinforce positive progress in the application of DiDIY to European education and research.

Introducing DiDIY approaches within existing educational institutions and practices is not easy since the institutions have evolved many systems, expectations and habits that work against this. This means that much creativity and possible learning opportunities are not realised. Specific solution patterns suggested include those that tackle: close format teaching, old and rigid assessment schemes, the difficulties in accessing DiDIY resources, student resistance to DiDIY approaches, a lack of attention to ethical aspects, and the low participation from female students.

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1. Introduction

1.1 Why policy “patterns”

The term “pattern” was coined by architect Christopher Alexander and popularized by his book “*A Pattern Language*” (APL) in 1977.

“At the core [...] is the idea that people should design for themselves their own houses, streets and communities. This idea [...] comes simply from the observation that most of the wonderful places of the world were not made by architects but by the people.”

The idea of pattern as proposed by Alexander has been especially influential in software engineering where design patterns have been used to document collective knowledge in the field. In this sense, a pattern is a general reusable solution to a commonly occurring problem within a given context – not a finished design but a template for how to solve a problem that can be used in different situations.

“[...] each pattern represents our current best guess as to what arrangement [...] will work to solve the problem presented. The empirical questions center on the problem—does it occur and is it felt in the way we have described it?—and the solution—does the arrangement we propose in fact resolve the problem [...] the patterns are still hypotheses [...] free to evolve under the impact of new experience.”

In this document, our aim is to make recommendations without being overly prescriptive. Rather, we wish to provide a “menu” of solution recipes that will work for different kinds of problems and circumstances. These should be concrete enough so that how to apply them in any particular situation should be clear but, at the same time, abstract enough so to be flexibly relevant to a range of circumstances/problems.

We develop a core of “policy patterns” as a result of the project expertise and results. Policy actors and other activists can browse the patterns online, selecting those that might be relevant to their situation then using their local knowledge in choosing, adapting and applying them. The patterns are also on Referata (didiy.referata.com/wiki/Main_Page), an open wiki-like server, where the wider community can continue to discuss, add to these and refine them, providing a longer-term, sustainable resource.

1.2 A pattern template

Each of the following policy patterns has been structured following a template. The table below provides the building elements of a pattern and a brief description of them.



Title	Word/short phrase for rapid retrieval
The problem is...	Definition of a problem, including its intent or a desired outcome, and symptoms that would indicate that this problem exists
The proposed solution might apply when...	Preconditions which must exist in order for that problem to occur; this is often a kind of situation
The solution proposed is...	Instructions, possibly including variants described in any appropriate way
The expected outcome is...	Result after the pattern has been applied, including side effects. It might include new problems that might result from using this pattern
Rationale	The thought processes that go into selecting this pattern, including an explanation of why this pattern works, and how forces and constraints are resolved to construct the outcome
Significant influencing factors	The various forces or constraints that impinge on the situation and how they interact. Some of the forces may be contradictory
Evidence/Example	Sample applications, solutions and known uses can help user understand the pattern
Related Patterns	Predecessors, antecedents, alternatives and anti-patterns



2. Policy patterns related to DiDIY in education

2.1 Closed format school teaching

Title	Closed format school teaching
The problem is...	Traditionally, school systems focused on the improvement of teachers' abilities in content delivery rather than in their ability to improve students' learning abilities.
The proposed solution might apply when...	As the 21 st century (digital) society is rapidly changing, schools are less able to transfer contents apt to remain useful during the whole student/person's lifetime; hence, what society should ask schools is less content transfer and more support to the students' development of learning abilities.
The solution proposed is...	A cultural shift is needed to recognize DiDIY and new technologies not only as a mere practical tool, but also, more importantly, as an opportunity to improve the (digital) culture of the society. Several possible complementary solutions are available, e.g., learning weeks for teachers; helping teachers to learn how to access existing resources, also via appropriate policies implemented by school principals.
The expected outcome is...	A more student-centred education, leading students to flipped classroom set-ups, based on self-education / student empowerment paradigm.
Other information	This pattern relates to situations strongly related to national cultural specificities, so that we can expect significant differences in different countries.
Rationale	In this rapidly changing social and technological context, learning abilities are much more important than in the past, but schools are usually unable to cope with this. "Education and training can only contribute to growth and job-creation if learning is focused on the knowledge, skills and competences to be acquired by students (learning outcomes) through the learning process, rather than on completing a specific stage or on time spent in school".
Significant influencing factors	Benefits obtained by the traditional paradigm, which produced significant improvements to society (in particular mass scholar education), in some cases seem still outweigh the expected benefits of the new paradigm. Not surprisingly, school is a complex, inertial system, starting from the hard change of support teachers in learning how to reconsider their educational role (consider the basic difference: teaching teachers how... vs supporting teachers in learning how...): it would be DIY "from the teachers' side". Students' evaluation has been modelled on the basis of the school-as-content-transfer institution framework so far, so that teachers lack ways to evaluate students as DiDIYers (assessing students' attitudes or skills is much harder than assessing their knowledge of contents – or their ability to repeat contents; a provocative case: is it better a right answer obtained in a wrong way – say, a purely mechanical and a-critic procedure --, or a wrong answer obtained in a smart and creative way? -- would, e.g., OECD PISA framework fit in this?).
Evidence/Example	Initiative such as RoboCup (www.robocup.org) and its junior versions (RoboCup Junior) has revealed over the year its remarkable potential in promoting robotics and AI research, offering to the public an appealing challenge. The RoboCup Junior is a "project-oriented educational robotics activity for students, with a focus on providing a hands-on, scaffolded environment where learners can grow by expanding their knowledge of, sparking their curiosity about and increasing their comfort with technology".



Related Patterns	Anti-pattern: teaching digital technologies and tools in the traditional, content-focused way, as the adoption of digital entities in education would be sufficient to solve the problem. Related pattern: Assessment of skill-based education
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2.2 Educational systems’ inertia in embracing new forms of education (or, on the need to “teach the teachers”)

Title	Educational systems’ inertia in embracing new forms of education
The problem is...	Despite the example of best practice and the successful experience of some schools, some teachers still appear reluctant in adopting new educational approaches based on the so-called DiDIY paradigm, which could benefit young generations of students.
The proposed solution might apply when...	This could be partially due to the teacher’s “fear” for new technologies, or for “not knowing enough” to use them with students.
The solution proposed is...	Work needs to be done locally, at the school level, to make school deans aware of the need for school teachers and educators to expand their knowledge and skills in order to be able to include digital tools and new technologies as effective educational approaches. At the same time, school policy makers (teachers’ unions, national ministries of educations, etc.) need too to be made aware of the need to invest resources into teachers’ training.
The expected outcome is...	By making teachers more self-confident in the use of such tools, they will be more prone to adopt them in a creative way, to fit their pedagogical needs and those of their pupils.
Other in formation	Teachers need to be empowered in their role of educators with respect to new technologies and digital competences. As a significant share of teachers still appear to be unable to attend updating courses due to lack of time outside school shifts and to the necessity of self-sustaining costs, they are not recognizing the added value of such new educational approach.
Rationale	In those contexts where students, families, and the society as a whole are asking for updated school curricula that can match the need to use new (digital) technologies in an efficient way, i.e. making the younger population able to exploit efficiently new technologies for the job market and for personal use, developing a proactive attitude toward them.
Significant influencing factors	New technologies and new learning environments are already entering schools.
Evidence/Example	Although there seems to lack a coordinated top-down coordination of training and high educational activities for teachers, in most EU countries, manuals, guidelines and training workshop are starting to appear for the benefit of school teachers, managers, as well as for other stakeholders involved in education outside classrooms (museums, associations, etc.) to plan and conduct the laboratory activities making use of digital technologies.
Related Patterns	Old assessment schemes for new learning environments



2.3 Old assessment schemes for new learning environments (or, on the need of an institutional intervention)

Title	Old assessment schemes for new learning environments
The problem is...	DiDIY-related activities are hardly included in school curricula because no standard assessment schemes are available yet.
The proposed solution might apply when...	One of the main hurdles to the widespread adoption of new educational attitude towards (digital) technologies is the practical and self-centred nature of DiDIY.
The solution proposed is...	Teachers should be actively involved in re-thinking the old assessment schemes in order to take into accounts new skills such as “digital literacy”. By defining competences in terms of learning outcomes and broadening the scope of tests and exams, assessment can be modernize to support learning.
The expected outcome is...	Equipping students with the right skills for the job market of today and tomorrow and for a competent use of new technologies for an effective citizenship (problem solving, critical thinking, and collaboration).
Other in formation	Outside school, individuals should also be able to have their skills assessed, validated and recognized, providing a skills profile for potential employers. Information on the quality and quantity of skills across the population will allow authorities to better map potential shortages and focus on areas with the best returns on investment.
Rationale	“What can be assessed often determine what is valued and what is taught”. This means that, when lacking recognized assessment procedures, activities falling outside the scope are often left behind.
Significant influencing factors	Assessment of competences towards assessment of abilities and knowledge?
Evidence/Example	The Centre for Educational Research and Innovation (OCSE) has pointed out the need of aligning evaluation and assessment frameworks with the desired pedagogical change. National guidelines are welcome to identify subject specific objectives related to the use of digital technologies, developing tools for benchmarking digital skills and other key competences.
Related Patterns	Educational systems’ inertia in embracing new forms of education

2.4 Finding resources to implement DiDIY in schools (or, on the importance of school deans as linking element between schools and external resources)

Title	Finding resources to implement DiDIY in schools
The problem is...	Schools lacking of the sufficient resources to offer DiDIY-related activities to students.
The proposed solution might apply when...	In medium-size cities, the number of fab labs and maker spaces is constantly growing, providing accessible resources (in terms of equipment and know-how).
The solution proposed is...	School staff should be made aware of the possibility of setting agreement with local resources (such as fab labs, coder dojos, and maker spaces) and open the schools to the local area, with mutual benefits.
The expected	Strengthened connection of schools with local territory, higher motivation of



outcome is...	students in engaging in DiDIY-oriented activities.
Other information	Lacking a specific training on new technologies and digital literacy hamper the ability of teachers and school manager to recognize and exploit the full potentialities of such tools. This leads to teachers having to self-finance their own permanent education, often using their own free time to attend them.
Rationale	In spite of the willingness of the more motivated teachers and school managers, finding resources (in terms of time and money) can be hard, especially in those contexts where funding for education are limited.
Significant influencing factors	Deans to allow teachers to train in DiDIY (through local resources) and facilitate the access of teachers to networks.
Evidence/Example	Some best-practice examples include the mutual benefit shared by those schools, which collaborate with local DiDIY space. The “ <i>do ut des</i> ” approach (a commutative contract whereby something is given so that something may be received in return) sees teachers and schools share their professional competences regarding didactics or content-specific knowledge in exchange of practical training on new technologies for them and their students.
Related Patterns	Educational systems’ inertia in embracing new forms of education Students’ resistance in adopting a novel attitude toward learning

2.5 Students’ resistance in adopting a novel attitude toward learning (or, on the key role of motivation in learning)

Title	Students’ resistance in adopting a novel attitude toward learning
The problem is...	Students inertia in adopting a proactive approach to learning.
The proposed solution might apply when...	Students’ attitude towards learning is limited to the completion of assigned activities and oriented, at best, to “get a good mark”, failing to acquire the ability to find their own customized solution to their potential future problems.
The solution proposed is...	Strengthen the connection of schools with the local resources, allowing students to engage in goal-oriented activities leveraging on new digital technologies to tackle real-life problems.
The expected outcome is...	Opening the schools to the local resources can help students appreciate the potentialities of new technologies in a real, practical environment.
Other information	By working with local fab labs and maker spaces, students and teachers can appreciate the practical connection of education with their lives and their community. This can boost motivation and engagement of students and, at the same time, can help teachers recognize the benefit of such a new educational approach.
Rationale	Despite being “advanced users” of the most common new (smart) technologies, students and young generation fail to appreciate the real potentialities of new technologies in terms of opportunities to “learn how to learn” successfully, as a by-product of applying new solutions to real-life problems. The ability to think critically, take initiative, problem solve and work collaboratively will prepare individuals for today’s varied and unpredictable career paths.
Significant influencing factors	Schools deans and managers play a pivotal role in opening the school to the local territory.
Evidence/Example	Besides engagement schema such as those successfully implemented in the project-



	oriented activities of initiatives of RoboCup Junior or First Lego League, school or class projects collectively agreed with students in collaboration with local fab labs or maker spaces can help motivating the students in changing their learning attitude.
Related Patterns	Old assessment schemes for new learning environments Finding resources to implement DiDIY in schools

2.6 Lack of attention to ethical aspects in the new learning environments (or, on the ethics of the use of technologies and participation of girls)

Title	Lack of attention to ethical aspects in the new learning environments
The problem is...	Digital literacy cannot come without honest considerations of the ethical implications on the use of new technologies.
The proposed solution might apply when...	Alongside the beneficial ones, new technologies come with a number of harmful potentialities. This is not due to their own nature, but rather to the potential human creativity, which, if not directed by good ethical consideration of mutual benefit, might lead to counterproductive results.
The solution proposed is...	Ethical aspects of the use of new technologies should be consider as a topic for discussion and teaching with students of all ages. Among others, their ability to use the Internet safely and responsibly.
The expected outcome is...	Students and young generation will be trained to: <ul style="list-style-type: none"> - protect their privacy and online reputation and respect those of others; - improve their confidence in their ability to use the Internet to protect themselves against online bullying, spam and junk mail; - judge the reliability of information found on the Internet; - identify online sources of reliable information; - use information found on the Internet without plagiarizing.
Other in formation	Tackling issues such as ethical implication of DiDIY activities can be considered part of a broader prospective including teaching and the open discussion in class about moral and ethical implications of the use of new technologies.
Rationale	Not all schools or class curricula include teaching ethical behaviour. Nonetheless, it is self-evident the importance and usefulness of such skills for a full participation of young generation to the social citizenship. Basic ethical behaviours may include kindness, equality, trust, and mutual respect. Now that technology is so intertwined with how we learn, ethics relating to the use of new technology needs to be added and continually revisited.
Significant influencing factors	Synergies with teachers and educators in the field of social sciences (history, sociology, philosophy, law, etc.) can be helpful in planning round-table discussions on the topics of social implication of DiDIY technologies.

2.7 Low participation of female students to the DiDIY movement

Title	Low participation of female students to the DiDIY movement
The problem is...	The number of female students in STEM-related activities is proportionally low.
The proposed solution might apply	Gender issues exist in society and culture in general, and the DiDIY community is none the less. Equal access to for female students to technology oriented studies and



when...	career paths is recognized as fundamental to drive societal change.
The solution proposed is...	Female role models (such as IT female teachers, or fab lab educators) seem to attract and, more importantly, retain the attention of female students. A broader and more active participation of female professionals in the educational process should be supported. Engaging tools such as LittleBits, developed by a female entrepreneur, appeal to both girls and boys and can help to disrupt the traditional association of electronics and technology with male students.
The expected outcome is...	Equal access for women to DiDIY technologies, spaces and communities, in and outside school.
Other information	It is also important to increase understanding of the career pathways followed by STEM graduates.
Rationale	In STEM-related activities (both at school and beyond), women are still far behind in terms of percentage of graduates and/or employees.
Significant influencing factors	A more holistic change at the societal level is needed. Nevertheless, careful promotion of DiDIY for all may help to lead change in the currently unequal fields of digital technologies. According to the Microsoft survey “Why Europe’s girls aren’t studying STEM”, there are five major factors driving girls’ interest in STEM: female role models, practical experience and hands-on exercises, teacher mentors, real-life applications, and confidence in equality.
Evidence/Example	Women in 3D printing (womenin3dprinting.com).
Related Patterns	Students’ resistance in adopting a novel attitude toward learning



3. Synthesis

The work done throughout the course of the DiDIY Project and, in particular, within the context of WP4 “DiDIY in Education and Research” can be summarized in the following key findings.

Society is changing rapidly, and partly this is due to the development of new technologies. Investigating the link between DiDIY and education, it clearly emerged the different paces between technology evolution and the current formal educational structure. In order to respond critically to this change, the adoption of new skills and knowledge should shift from short-term, technology-oriented knowledge, to a flexible, long-term approach to “novelty”.

Schools are now progressively moving from a content-delivering role to a more broad approach including the acquisition of transversal skills such as a flexible attitude to cooperation, communication and entrepreneurship. It is now commonly accepted that 21st century skills comprise creativity and innovation, critical thinking, problem solving, decision making, and an open attitude to life-long learning. The research carried out in the context of this WP confirmed this.

While the level of change required in schools is significant, it is best supported in the short to medium term by changing the emphasis of existing curricula and assessment, encouraging schools to use multiple types of assessment. For example “When assessing students, it is always worth asking what type of skills will students need to lead a successful life” (OECD, 2015)

New technologies possess the potentialities to drive new approaches of innovative learning centred around the person and closer to the need of the territory. The DiDIY-related educational activities can potentially make the school laboratory work meaningful to the student, thus enhancing the learning experience and helping reinforce motivation to learning.

However, creating such a new learning environments requires a systems approach which must include building teacher capacity. Innovating education is not possible without innovating teaching schemes. Awareness and participation of teachers is mandatory to share best practices and starting a virtuous cycle.

We understand that digital learning is most successful when it combines formal and informal learning and digital technologies should be used to enhance social inclusion and facilitate student-centred learning. Learning time for young generation is no longer limited to the school environment, but rather continues outside the school wall by engaging in social and digital activities on the Internet. This can both lead to a better and more personalized learning experience, but it is also limited by the lack of informed supervision, which, if the youngster is not duly trained in the ethical and moral aspects of new technologies, can lead to unfavourable outcomes (use of unreliable source of information, being victim or perpetrators of bullying behaviours, etc.).

At the EU level, all countries are facing similar problems in terms of employability of new generations and senior citizens. For this reason, we believe that the European Commission together with all European national systems should continue to drive investment in education. In this context, pedagogy and ethics must drive innovation in digital education. Of crucial importance is the ability of national systems to build a skilled and dedicated teacher workforce, attracting and retaining qualified teachers and ensuring that they continue to learn throughout their careers.

When considering learning science and science-related subjects, we too believe that giving young students the opportunity to learn science in school will lead to a better informed future citizens which will be able to fruitfully exploit the potentialities of the research results, understanding at the



same time the limitation and ethical implications of such information. A cultural shift is needed to recognize DiDIY and new technologies as an opportunity to improve the (digital) culture of the society. Work needs to be done locally to make school deans aware of the need for school teachers and educators. Strengthen the connection of schools with the local resources, allowing students to engage in goal-oriented activities leveraging on new digital technologies to tackle real-life problems, is a key issue.



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