Design FILS

Designing Future Innovative Learning Spaces

Scenario-Based Learning: Literature Review around key themes to support FILS Scenarios

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Information

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Abstract

The aim of this document is to present the literature review around the key themes chosen for Future Innovative Learning Space (FILS) Scenarios. These draw on the concepts of active learning pedagogies in technology-enhanced classrooms. The literature review seeks to introduce the methodology of Future Classroom Lab (FLC) scenarios development – as the methodology in teacher professional development. Primarily, it presents the literature around the key pedagogical approaches, their benefits, challenges, and key principles of implementing them. The literature review becomes the foundation for the *FILS Learning Scenarios* developed by the project partner institutions.

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1. Scenario-Based Learning as Methodology in Teacher Training

1.1. Rationale for Learning Scenarios

There is considerable discussion in the literature on the need to move towards innovative models of teaching and learning and the challenging nature it represents (e.g., Fullan & Langworthy, 2014). It is often argued to lack examples of how innovation can be implemented within mainstream schools (Brecko, Kampylis & Punie, 2014). The OECD Report Teacher as Designers of Learning Environments (Paniagua & Istance, 2018, p. 24) suggests that "providing experiential, iterative, action-oriented learning with teachers collaborating in well-targeted communities of practice" is critical in bringing about change in pedagogical practice. The ITELab Project (http://itelab.eun.org/) tried to address the issue by targeting Initial Teacher Education and engaging pre-service teachers in innovative learning scenarios and even involving student teachers as part of the team in the co-design process and building a network of innovating teachers who might make a change to the system.

Scenario-based learning represents a kind of authentic pedagogy that can bridge the gap between theory and practice (Errington 2011). Literature suggests that scenarios aim to provide a meaningful context for the concepts and principles that relate to professional work (Abrandt Dahlgren & Öberg, 2001). Matos (2014) argued that the use of learning scenarios can be a way of promoting the development of skills for the twenty-first century, namely those related to problem solving, communication, critical thinking and creativity. Since scenarios help people to break out of established ways of addressing situations and problems, scenarios stimulate creative ways of thinking (Wollenberg et al., 2000). In teacher education and professional development, learning scenarios can be an effective strategy to enhance reflection while planning teaching activities in technology-enhanced learning spaces (Pedro et al., 2019).

There are a number of definitions of learning scenarios. In the Innovative Technologies for an Engaging Classroom (ITEC) Project, scenarios were defined as "short narratives of preferable learning contexts which are set within a model learning environment" (ITEC.eun.org). They take account of the different elements within the learning environment such as the activities and tasks (what happens in the scenario), environment (where the scenario is happening), roles (who is involved in the scenario), interactions between the other elements (how the scenario happens), and resources (what is required to support the scenario). The approach has been applied in a number of EUN projects for teacher education and professional development since its development in ITEC: e.g., Europeana, ITELab (Initial Teacher Education Laboratory), Scientix, Future Classroom Lab Regio.

The FILS Project adopts the idea of learning scenarios as key to planning teaching activities in technology enhanced learning spaces. The idea is to develop a generative, flexible, learning methodology that embodies an innovative and creative approach to enhance pedagogy, and meaningful learning educational experiences for teachers. In FILS, the scenarios aim to explore and illustrate the potential of technology and space in teacher education for European classrooms, and are designed in response to the realities and challenges facing teachers in the present and nearest future.

1.2 Scenario Development Process

FILS Scenario development process is underpinned by the following principles:

- an ambitious but realistically achievable educational vision;
- participatory design strategy;
- innovative teaching practices;
- trends and drivers that are affected by education;
- based on the context and users' needs;
- a dynamic process of experimentation, reflection and evaluation. It also should take advantage of digital technologies and space that can be mobilised in different stages of the scenario implementation.

Matos (2014) defined a set of characteristics for a learning scenario:

- Innovation – A scenario should demonstrate possible innovative activities - in order to create pedagogical value - and not provide prescriptive plans to teachers.
- Transformation – A scenario should encourage teachers to experiment changes in their pedagogical practice in a transformative way.
- Foresight – A scenario should be considered as a planning tool used to take a prospective stance making appropriate decisions regarding complex and uncertain conditions.
- Imagination – Scenario design calls for imagination and should be a source of inspiration and nurturing the creativity of the teacher.
- Adaptability – A scenario is not a rigid tool pointing to learning opportunities in a unique way, being up to the teachers to adapt it to their objectives and to the characteristics of their pupils.
- Flexibility – A scenario should provide options targeting different learning styles, a variety of space organization and individual teaching styles. Teachers should be encouraged to recontextualize the learning scenario and use it at an elementary level or make it more complex.

- Amplitude – A scenario should be designed to have a greater or lesser extent and cover different scientific areas. Scenarios may include multidisciplinary activities to be worked on by students over extended periods of time.
- Collaboration – A scenario should contain elements that stimulate collaborative activities (synchronous and/or asynchronous) and include resources such as digital technologies that facilitate sharing and collaborative construction of learning.

The FCL toolkit[1] describes three stages of a Future Classroom Scenario design: 1) bringing together a number of diverse stakeholders to identify important emerging trends which are likely to have an impact in learning and teaching in the future; 2) groups of teachers, often from different subject areas and backgrounds working together in a design workshop to create innovative learning activities (a concrete description of a unit of a teaching and learning experience which is not subject-specific and can be used across the curriculum); and 3) testing and evaluating learning activities in the classroom.

Pedro et al. (2019) describes the Cycle of Learning Scenario Design for Initial Teacher Education. The Cycle consists of four key phases: planning, production, implementation and evaluation. The planning phase (1) includes a reflection and discussion process, identification of the idea and the addressed theme or the problem to be solved. Brainstorming methods are used to acknowledge and analyse the idea, problem, learning objectives etc. In the production phase (2), a model or template is used, the ideas drawn in the planning stage are organised, appropriate resources are selected, and the forms of assessment of pupils' learning are defined. These are produced by the student-teacher and discussed and evaluated by the university colleagues and/or educational centers. In the implementation phase (3), the student-teacher implements the scenario followed by immediate feedback and suggestions made by the supervisors. The evaluation phase (4) should inform teachers and pupils about the achieved goals and the ones where problems arose. Importantly, the approach values the students' role in the design process, holding students responsible for their contribution in all stages of the activity since its planning.

Both scenarios development approaches are of collaborative nature that aim to stimulate creative and critical thinking, reflectivity, enhance teachers' ability to adapt to change, and capability to implement new practices and methods. Importantly, they give opportunities to interact in a community of professionals, ensure content consistent with wider policy trends and engage student teachers and teachers in the learning process. These are considered as crucial to create effective contexts for professional development (Timplerley et al., 2007).

[1] https://fcl.eun.org/toolkit

1.3 Framework for the FILS Learning Scenarios Development

The previous section outlined the key principles for Learning Scenario Development. This section briefly introduces the framework for FILS Learning Scenarios. The key focus of the FILS Learning Scenarios is on presenting the innovative pedagogies in action and bringing in the emphasis on how space and technology can support teaching and learning. The framework includes the following key elements:

1. Narrative Overview is the key element that describes the rationale for a chosen pedagogical approach in detail.
   1.1 Setting the scene
   1.2 Key objective
   1.3 Relevance (educational; societal etc.)
   1.4 Key idea of the Learning Scenario
2. Learning objectives of the Scenario
3. Roles Description:
   3.1 Teacher(s)
   3.2 Students
   3.3 Others' roles such as parents, external experts etc.
4. Description of learning activities
   4.1 Learning activities (presentation; research; team work; reflection etc.)
   4.2 Learning environment (inside/outside the school building; virtual/real life)
   4.3 Required materials and resources
5. Literature to support the Learning Scenarios

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2. Themes for FILS Learning Scenario Development

The FILS Themes for Scenario Development address the key education trends which highlight the importance of creative and collaborative problem-solving, inquiry, application-based and multi-disciplinary syllabus, communication and social skills, digital literacy, personalised and inclusive learning environments, and the role of play. Also, due to Covid-19 restrictions for face-to face learning, the approaches connected to blended and distance learning have been foregrounded and this was taken into consideration.

Thus, the FILS themes for learning scenarios bring together innovative pedagogical approaches that draw on these educational trends and could be tried out either or both in school (primary and secondary) by teachers, and in teacher education by teacher trainers for teachers' professional development. The themes are aligned with the Methodological Framework for Innovative Classroom Training, and encompass approaches that require careful consideration of learning space and use of technology for teaching and learning. The literature review in this section aims to bring the existing knowledge around the chosen approaches which become the ground for the FILS learning scenarios and can be grouped under specific trends. Each subsection is structured around the affordances and challenges to implement an innovative pedagogical approach, and suggestions around how to put it into practice. Each approach described below aims to engage learners in technology-enhanced learning and develop digital skills. Each approach makes use of the six concepts of learning zones described in the Methodological Framework for Innovative Classroom Training and thus addresses the need to engage students in individual and collaborative work, reflection on and in learning, sharing of one's work.

2.1 Innovative approaches to enhance creative and collaborative problem-solving

2.1.1 Inquiry-based learning

Introduction

Inquiry-based learning is an active learning pedagogical approach that emphasizes the student's role in the learning process, and aims to enable students to learn about a topic through self-directed investigations. These investigations are usually governed by a number of research questions proposed by a teacher or by the students themselves. Thus, students are encouraged to explore the material, ask questions, propose scenarios and share ideas.

Benefits

Several quantitative studies support the effectiveness of inquiry-based learning as an instructional approach (Alfieri et al., 2011). Instead of memorizing facts and material, **students learn by doing.** This allows them to build knowledge through exploration, experience and discussion. In essence, students enhance their learning experiences, take ownership of their learning, increase their engagement with the learning process and feel members of a responsible learning community. Inquiry-based learning teaches lifelong skills needed for all areas of learning, fosters curiosity and deepens their understanding of topics.

Challenges and Barriers

Many teachers find implementing inquiry-based learning as a challenge due to the student's abilities to achieve specific learning goals and time constraints.

Furthermore, there are traditional barriers such as the fear of the unknown and also the resistance to change the way of teaching. They still see the content (as prescribed by curriculum) as a body of knowledge to be imparted to students using traditional tools (textbooks, worksheets etc.), rather than inquiry-based activities.
Research also suggests that inquiry-based learning can be effective as long as the students get adequate support (Lazonder & Harmsen, 2016). It is important to provide the necessary guidance to the students to assist learners in accomplishing the task and learn from the activities.

Put into practice

Inquiry-based learning is organized around a cycle with five basic steps (Pedaste et al., 2015) that should represent the outline of a simple scenario.

1. Orientation:
In this first step, relevant variables are identified and the problem to be investigated is defined. Curiosity is aroused about the topic to be investigated (Scanlon et al., 2011). Teachers **interact** with the students with a goal to engage them in the classroom, they make students co-actors in the process. Teamwork is an important element here while investigating, exploring and discussing - learning to communicate and work with others, the students **exchange** their ideas. Importantly, while the teacher can propose a topic or problem to be worked on as a group, it is up to the students to decide how to plan the

learning process and they decide on that as a team. Students discover for themselves, however guided by the teachers' questions that aim to enhance students' critical thinking skills and encourage students to formulate their own questions. It is not a matter of asking big generic questions such as "How does the human being work? '' but more concrete questions (What solids sink and what floats? How does the pulse rate vary when exercising?) to stimulate thinking.

2. Conceptualization:

Students develop a problem statement that compels them to pose their question and find hypotheses to be tested on. They can read a guide in groups and make sure they understand what the investigation consists of and the steps they have to take.

Students **investigate** a topic: they learn to analyse, synthesize and relate the information provided with the help of the teacher. The teacher scaffolds students' learning. Several tools can be used to create brainstorming or mental maps. The flexible furniture makes it possible to reconfigure the physical space quickly to enable work in groups, pairs, or individually, and for a teacher to come to each group, and for the students.

3. Research:

The process of data collection and analysis is planned and executed in order to provide solutions to the questions posed (Lim, 2004). Students continue their **investigation**. Students give answers to questions, activating their previous content knowledge. In groups, they will accept or reject the hypotheses, depending on whether they coincide or not with their experience. It is crucial to research the topic using time in class, so students have access to the teacher, who guides them and models methods of reliable research. Students can make use of simulators to check the work of the research.

4. Conclusions:

Conclusions are drawn from the information obtained (de Jong, 2006) and the results of the analysis are compared with the hypothesis initially proposed (Pedaste et al., 2015). Now there is time for the students to **develop** their conclusions independently.

Students reflect on the results obtained and communicate their conclusions. If all the students are doing the same research, they can do it in a large group, in other cases, if each group is investigating different hypotheses, each one will **share** their results and conclusions with the rest.

5. Discussion:

Students **reflect on** what worked about the process and what did not and could propose new problems for another inquiry cycle (Scanlon et al., 2011). Reflection on the process itself is key because it allows working in metacognition and focuses students on how they learned in addition to what they learned.

Finally, students **present** their findings and conclusions and receive feedback and comments from others (Scanlon et al., 2011).

Based on the discussion students can **develop** a report with the essentials of the topic and propose some exam questions to the teacher. It is interesting to ask students to

create and present a final product that supports their presentation. There is a need for a space that allows the students to plan, design, and produce their final presentation, learning by creating and using engaging technology (like audio-visual media). They **develop** their final presentations independently and **present** the final results to the class. The role of the teacher is that of a facilitator of learning by **guiding** learners through the process. The teacher provides the elements for specific learning to take place. He/she must generate a cognitive conflict (Moreira et al., 2003) in the students using a dialectical technique that allows them to carry out a process of analysis of their actions, which builds their knowledge and develops their skills. The main instrument of the teacher is questions and questioning. Questioning students will develop the ability to criticise themselves and to base their reasoning about different situations on evidence. It is important to make students understand that the process is as important as the results.

The teacher is not the possessor of all knowledge. A teacher needs to generate an active learning environment which will allow students to be more involved in their own learning process.

It should be noted that teachers' guidance is very important in inquiry-based learning. Adequate guidance is not the same as highly specific guidance. Teachers aim to create guided learning environments that give learners enough freedom to examine a topic or perform a task on their own (Lazoner & Harmsen, 2016).

Below is the Typology of inquiry learning guidance (Table 1).

Process constraints can be described as the least specific type of guidance and intended for students with matured inquiry skills. This sort of guidance is about organizing the inquiry into a series of manageable subtasks. Status overviews are more specific as they summarize what and how well each student has performed for example with the Participation Tool. Prompts are timed cues that remind the students to perform a particular activity. They tell the students what to do at appropriate moments during the inquiry. These types do not guide students around how they need to perform activities.

The rest types of guidance all provide guidelines on how to perform a certain activity. Heuristics remind students to perform an action and point out possible ways. Scaffolds offer more specific guidance: they assist students in performing activities by explaining what to do and how to do it, and provide designated means to structure or simplify actions. Scaffolding needs to be removed once students perform activities without assistance. Finally, explanations offer the most specific type of guidance and are needed for students who lack the basic ability to perform an inquiry skill.

Type of support	Basic idea	Intended audience
Process constraints	Restrict the comprehensiveness of the learning task	Learners who are able to perform and regulate the basic inquiry process, but still lack the experience to do so under more demanding circumstances
Status overviews	Make task progress or learning visible	Learners who are able to perform the basic inquiry process, but lack the skills to plan and keep track of their learning trajectory
Prompts	Remind to perform an action	Learners who are able to perform an action but may not do so on their own initiative
Heuristics	Remind to perform an action and suggest how to perform that action	Learners who do not know exactly when and how an action should be performed
Scaffolds	Explain or take over the more demanding parts of an action	Learners who do not have the proficiency to perform an action themselves or cannot perform the action from memory
Explanations	Specify exactly how to perform an action	Learners who are (largely) incognizant of the action and how it should be performed

Table 1. Typology of Inquiry Learning Guidance (Based on T. De Jong and Lazonder (2014))

Students have a fully active role within the learning experiences designed by the teacher (Harlem, 2012). Students are responsible for their own learning and they must rely on the teacher, seeing them as a guide rather than an expert who holds all the answers. At the highest stage of the enquiry, the two could be seen as fellow researchers in the same process of answering a question that has arisen from the learner's interest.
At the end of the process, students should go through a phase of metacognitive activity where they rescue those strategies or actions that led them to gain new knowledge. This process of reasoning and reflection is continuous throughout the development of the activity.

An example of putting the approach in practice can be found here: Nurturing Curiosity: Inquiry-Based Learning and Video

Conclusion

Inquiry-based learning as an active learning pedagogy can be contributing to the development of higher order thinking skills. According to Bloom's Taxonomy, the ability to analyse, synthesize and evaluate information or new understandings indicates a high level of thinking (Krathwohl, 2002). In inquiry-based learning, teachers' adequate guidance plays an important role and should be encouraging divergent thinking and allowing students the freedom to ask their own questions and to learn effective strategies for discovering the answers. The higher order thinking skills that students have the opportunity to develop during inquiry activities will assist in the critical thinking skills that they will be able to transfer to other subjects.

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2.1.2. Creative Problem-solving

Introduction

Dealing with hurdles and difficulties is a daily feature of everyday life, and managing them is not always easy. To develop our plans, programmes, networking, and interpersonal skills, we need to encourage and inspire new thinking and find unique ideas that work. To do so, creative problem solving advises splitting the "divergent" and "convergent" reasoning. Divergent reasoning, also known as brainstorming, is the practice of creating a large number of possible options and possibilities. Convergent reasoning entails weighing certain alternatives and selecting the most promising one. We sometimes combine the two to come up with new ideas or solutions. Using them both at the same time, on the other hand, will lead to unbalanced or biased decisions, as well as stifle idea generation (Puccio et al., 2005; Puccio et al., 2011). Creative problem solving is a technique for using the imagination to come up with new concepts and solutions to problems. The method is focused on distinguishing between divergent and convergent reasoning types so that one can centre her/his attention on first making and creating, and then analysing.

The Fundamentals of Creative Problem-Solving

There are four key rules of creative problem-solving (Frestien, 2017a; Osborn, 1957; Oh, 2019). This section takes a closer look at each one:

- Divergent and convergent reasoning: It is necessary to find a balance between divergent and convergent reasoning. Learning to recognize and reconcile divergent and convergent reasoning (done separately) and recognizing when to exercise both is crucial to innovation.
- Asking problems as questions: When one thinks about questions and obstacles as open-ended, it is easier to solve them. When one asks these types of questions, s/he will get a lot of rich detail, while when one asks closed questions, s/he will get brief responses like confirmations or conflicts. Problem statements usually elicit only a few responses, if any.
- Deferring or postponing making a decision: As Alex Osborn (1957) discovered during his brainstorming sessions, judging options early on threatens to stifle the generation of new ideas. Instead, at the convergence period, there is an acceptable and required opportunity to judge concepts.
- Instead of "No, but," focussing on "Yes, and": When it comes to extracting facts and concepts, language is crucial. "Yes, and" helps people to broaden their thinking, which is important at times during creative problem solving. When followed by

"yes" or "no," the phrase "but" concludes the discussion and sometimes negates what came before it.

According to Baumgartner (2010), seven steps of creative problem solving start with clarifying and identifying the problem (step 1). Then, one needs to start researching the problem (step 2) so that s/he can formulate creative challenges (step 3) and generate ideas about them (step 4). The other step is combining and evaluating the ideas (step 5) such that one can draw up an action plan (step 6) and finally implement the ideas (step 7).

Benefits and Challenges of Creative Problem-Solving

Creative problem solving provides various benefits (e.g., OECD, 2004; 2014). Researchers, academicians, and policy makers agree on doing what it takes to train students for work in the age of globalization, and creative problem solving is stated as one of the key skills for students to have for their future lives. In an Adobe-commissioned global Creative Problem-Solving study (2018), the data analysis showed an evident mismatch between what students need to learn about and what teachers are required to teach in many countries, with the one skill that isn't being taught being creative problem-solving. Creative problem-solving is one of the 21st century skills, which not only helps students with their academic success but also helps them with their future jobs. Aforementioned study lists benefits as follows (Adobe Commission, 2018, info sheet):

1. Creative problem solving is important for students to learn in school.

2. Professions that require creative problem-solving skills are less likely to be impacted by automation.

3. Students who excel at creative problem solving will have higher-earning jobs in the future.

4. Creative problem-solving skills are in high demand today for senior level/ higher-paying careers.

Whilst there are various benefits, there are always challenges. The biggest challenge is that many educators and policymakers think that there is not enough emphasis on creative problem solving in today's education programmes. In fact, other skills identified globally as most important to creative problem solving are currently playing a minimal role in today's curricula (Adobe Commission, 2018). In reality, other skills that have been identified as being critical to creative problem solving on a global scale are currently underrepresented in today's curricula (ibid). These skills include Independent learning, Learning through success and failure, Working within diverse teams, Self-expression and dialogue, Persistence, grit & entrepreneurial spirit, Accepting challenges and taking risks, Conflict management and argument and Innovative thinking. Although it is hard to change all the programmes at the same time, it should also be noted that starting with small changes seems necessary.

Put into practice

Creative problem-solving begins with identification of a problem or challenge. The teacher's role here is very important since this is one of the most challenging stages - to critically evaluate what could have been missed to understand an issue fully, and to define the objectives. The teacher **interacts** with the students by guiding them through the process of understanding the problem, collecting information about it, and formulating a question or problem; the teacher is seen as a process expert (Firestien, 2017b). Next, the students **exchange** their ideas in teams to answer the challenge question or problem. Working in teams is important to foster collaboration and creativity, as students can take different roles within a team: people who generate options or ideas, people who identify a challenge and decide on the plan of action (Friestien, 2017b) Technology can support brainstorming and the process of ideas exploration to foster students' engagement (Samson, 2015). This is the stage when creativity comes into play. The teacher acts as a facilitator of a discussion within teams.

Then the students are encouraged to work independently and **develop** solutions in a creative way. This is the stage where the students need to evaluate all possible options and come with solutions. Students actively look for solutions and analyse the best ones during these activities (VanGundy, 2005). They **create** a plan based on the best solution.

Finally, the students can use a range of different tools and skills to **present** and communicate their plan. They receive feedback from the teacher and peers (Kivunja, 2014).

An example of putting the approach in practice can be found here: Creative Problem Solving and Video

Conclusion

To sum up, creative problem solving is a method of developing new ideas and solutions to challenges by using our imagination. The approach is focused on distinguishing between divergent and convergent cognitive modes, helping one to concentrate her/his thoughts on producing an idea first and analyzing later. It has various advantages including enhancing learning and increasing job opportunities, and challenges including education programmes' readiness for the integration, but still considered to be highly valued in education in various disciplines from maths to science, and from geography to fashion design education.

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2.1.3 Maker-Centred Project Learning Pedagogy

Introduction

While the act of making is a fundamental human activity, the emergence of both communication technologies have given rise to what has been termed *the maker movement* (Dougherty, 2016). The maker movement is a term for "a community of hobbyists, tinkerers, engineers, hackers, and artists who creatively design and build projects for both playful and useful ends" (Martin, 2015, p. 30). The culture of making and the maker movement might be captured as simply makers making things, often by adapting and reusing older things, for particular purposes. Elements of maker movement have raised interest from education institutions that led to integration of maker-centered learning (Clapp et al., 2016), i.e. learning through making. The maker-centered learning framework is based on constructionist theoretical frameworks and provides clear parameters to help practitioners integrate maker-centred learning. The connection between STEM content areas and maker-centred learning is often manifested in the learning spaces called *makerspaces.* Next, the pedagogical affordances are considered which are made possible by developing interest in making things as part of any curricular subject.

Benefits

The key principles of 'Making' include:

- Technologies, digital and otherwise, can offer novel opportunities for problem-solving in multi-disciplinary ways.
- Making can emphasize process over product, particularly given that the processes of making require learners to encounter, and work through, mistakes and problems.
- Making encourages collaboration among groups of learners from a variety of disciplinary backgrounds; these collaborations feature a commitment to the sharing of knowledge, a spirit of inclusiveness, and openness of learning.
- Promote in each student the full capacity, creativity and confidence to become agents of change in their personal lives and communities (Bullock & Sator, 2015).

Further, research suggests maker-centered learning activities may attract greater numbers of students to pursue opportunities in STEM content areas (Martin, 2015). It may also strengthen learning in STEM subject matter (Litts et al., 2017), as making can reinvigorate both teachers and learners, e.g through the excitement and motivation the maker movement can embody and through the artefacts students create and share (Bers et al., 2018). Importantly, 'makers' seem to be developing dispositions that prod their own efforts to think outside of the box and make or create (Loertscher et at., 2013).

Challenges and Barriers

Before teachers can skilfully integrate maker-centered learning into their existing curriculum they must be educated on maker-centered learning strategies (Jones, Smith, & Cohen, 2017). Indeed, maker-centered learning requires the teacher to become a facilitator and understand their new role in the acquisition of knowledge through maker-centered learning activities. It asks for a motivated and competent teacher.

Setting up and using a makerspace in a school presents many challenges and schools have more or less difficulty addressing these dependent upon factors such as their location and culture, financial circumstances, leadership and the amount of assistance they can gain through partnerships or sponsorship (European Schoolnet, 2020).

Put into practice

The uTEC Maker Model (Loertscher et at., 2013) visualizes the developmental stages of creativity from individuals and groups as they develop from passively using a system or process to the ultimate phase of creativity and invention. As illustrated in the model below, there are four levels of expertise.

Figure 1. Loertscher et al.'s (2013) uTEC Maker Model (source: European Schoolnet, 2020)

Specific pedagogies enabled by the maker-centered learning include:

- Constructivist learning or learning by doing
- Inquiry learning, including learning by trial and error, seeing failures as part of the process
- Making design decisions based on real experiences
- Collaborative learning, including working in teams

- Coaching and supporting students rather than traditional teaching
- Project-based methodology.

At the beginning, introductory projects are recommended: short projects, perhaps within specific teaching units, that offer students the opportunity to carry out activities that require basic knowledge in a technical and disciplinary domain. As the students develop their skills, long-term projects can be implemented: ambitious projects that may simulate a professional context; designed, proposed and implemented by individuals or, preferably, teams. These projects may be related to competitions for students and require project management as well as making skills.

One pedagogy which can be placed within the Making Movement deserves a special mention - **tinkering.** The tinkering approach is characterized by a playful, experimental, iterative style of engagement, in which makers are continually reassessing their goals, exploring new paths, and imagining new possibilities (Resnick & Rosenbaum, 2013). It can be seen as a form of flexible learning. Resnick and Rosenbaum (2013) describe how tinkerers begin by messing around with materials (e.g., snapping Lego bricks together in different patterns), and a goal emerges from their playful explorations. Sometimes, tinkerers can have a general goal, but they are not sure how to get there. They can start with a tentative plan, but continually adapt their plans based on their interactions with the materials and people they are working with. Tinkering is closely aligned with play. It can be seen as a playful style of designing and making, where one constantly experiments, explores, and tries out new ideas in the process of creating something. Tinkering can be seen as a seemingly undirected process, driven by curiosity and playfulness. Problems and challenges are self-defined. The process involves the iteration of prototyping, observing, reflecting, definition of a new challenge, and failing (Mader & Dertien, 2016). In sum, it is an integral element of the making process.

In the maker-centred approach, the students are encouraged to take different roles of a Maker, creator, builder, inventor, a dreamer, working individually or in a team, a coach and mentor, a presenter, and a leader of a project. The teacher's role is to support and encourage students' creativity, provide students with the necessary knowledge and skill, and create a rewarding and safe environment. It is important that the teacher can (re)-design activities in ways to enable the students' growth using new equipment and skills, and make connections between theory and practice. It is also encouraged that teachers and students work together.

Activities can be highly structured, guided or more informal. At times, the learning process can look chaotic. Activities can happen during timetabled school hours and be more teacher directed and curriculum relevant, or students can be given access outside of school hours to pursue their projects.

The basic tools needed in a makerspace are related to everyday creativity, including design, measuring, cutting, pasting and screwing. These actions are carried out by students of all ages, and this can include kindergarten classes. Of course, attention must also be paid to the tools, for example blunt ended scissors for young children, and to the accessories needed to ensure a safe operating environment, including gloves, dust masks, safety glasses, etc. A detailed Guidelines on how to set up and use makerspaces can be found in the European Schoolnet Guidelines (2020).

An example of putting the approach in practice can be found here: Learning by Making and Video for Making Pedagogy; and Tinkering and Video

Conclusion

Maker-centered learning leads to significant changes in teaching and learning. It means think differently, teach differently, collaborate often, build pedagogical partnerships in and outside of school, create multi-age and interdisciplinary collaborations. The pedagogy embraces the tolerance for failure, confusion and improvisation that accompanies social constructivist learning, and confidence in spontaneous cooperation. Creating the conditions for maker-centered learning can be however challenging and depends on making a case to administrators.

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2.1.4 Computational Thinking

Introduction

A variety of terms (e.g., coding, programming, algorithmic thinking) are used in the literature to refer to Computational Thinking (CT). These reflect differing perspectives on CT (e.g., that it implies more than "computing"). Computational Thinking (CT) is defined as a problem-solving process that includes a number of characteristics and dispositions relevant to learning in the twenty-first century (Bocconi et al., 2016).

Computational thinking can be defined as "the thought processes involved in formulating a problem and ex-pressing its solution(s) in such a way that a computer—human or machine—can effectively carry out" (Wing 2017, p.8).

Mainly, Computational Thinking (CT) is described as a problem-solving process that includes (but is not limited to) the following characteristics:

- Formulating problems in a way that enables us to use a computer and other tools to help solve them;
- Logically organizing and analysing data;
- Representing data through abstractions such as models and simulations;
- Automating solutions through algorithmic thinking (a series of ordered steps);
- Identifying, analysing, and implementing possible solutions with the goal of achieving the most efficient and effective combination of steps and resources;
- Generalizing and transferring this problem-solving process to a wide variety of problems (Bocconi et al., 2016).

Wing (2017) sees the abstraction process as the most important and high-level thought process in CT. Abstraction is used in defining patterns, generalizing from specific instances, and parameterization. More related characteristics of CT are listed in the table below (See Table 2).

CT Skill	Definition
Abstraction	Abstraction is the process of making an artefact more understandable through reducing the unnecessary detail. The skill in abstraction is in choosing the right detail to hide so that the problem becomes easier, without losing anything that is important. A key part of it is in choosing a good representation of a system. Different representations make different things easy to do (Csizmadia et al., 2015, p. 7).
Algorithmic thinking	Algorithmic thinking is a way of getting to a solution through a clear definition of the steps (Csizmadia et al., 2015, p. 7).
Automation	Automation is a labour saving process in which a computer is instructed to execute a set of repetitive tasks quickly and efficiently compared to the processing power of a human. In this light, computer programs are "automations of abstractions" (Lee, 2011, p. 33).
Decomposition	Decomposition is a way of thinking about artefacts in terms of their component parts. The parts can then be understood, solved, developed and evaluated separately. This makes complex problems easier to solve, novel situations better understood and large systems easier to design (Csizmadia et al., 2015, p. 8).
Debugging	Debugging is the systematic application of analysis and evaluation using skills such as testing, tracing, and logical thinking to predict and verify outcomes (Csizmadia et al., 2015, p. 9).
Generalization	Generalization is associated with identifying patterns, similarities and connections, and exploiting those features. It is a way of quickly solving new problems based on previous solutions to problems, and building on prior experience. Asking questions such as *"Is this similar to a problem I've already solved?"* and *"How is it different?"* are important here, as is the process of recognising patterns both in the data being used and the processes/strategies being used. Algorithms that solve some specific problems can be adapted to solve a whole class of similar problems (Csizmadia et al., 2015, p. 8).

Table 2. CT Core skills and Definitions (Source: Bocconi et al., 2016)

A number of authors also attribute CT certain dispositions and attitudes. For instance, Barr, Harrison and Conery (2011) and Weintrop et al. (2015) suggest that CT should develop confidence in dealing with complexity, the ability to handle ambiguity and open-ended problems, and the ability to work and communicate with others to achieve a common goal. Wollard (2016) names tinkering, creating, debugging and collaborating as key elements of CT.

Thus, CT can be described as a set of skills, and certain attitudes which are being developed while developing CT skills.

Benefits

Two main trends emerge regarding the rationale for including CT in compulsory education: 1. developing CT skills in children and young people to enable them to think in a different way, express themselves through a variety of media, solve real-world problems, and analyse everyday issues from a different perspective; 2. fostering CT to boost economic growth, fill job vacancies in ICT, and prepare for future employment.

Literature suggests that CT can enable children and young people to think in a logical way while solving problems, to analyse everyday issues from a different perspective (Lee et al., 2011), to develop the capacity to discover, create and innovate (Allan et al., 2010), or to understand what technology has to offer. Different authors suggest a wide variety of skills related to CT acquisition, such as: problem-solving, examining data patterns and questioning evidence; collecting, analysing and representing data, decomposing problems, using algorithms and procedures, making simulations; using computer models to simulate scenarios; dealing with open-ended problems and persisting in challenging cases; and reasoning about abstract objects (Bocconi et al., 2016). Mitchel Resnick also stresses the connection with language, viewing computation as literacy: CT is a way of expressing ourselves and understanding the world using computers and computational ideas.

In brief, the research has shown that teaching CT or integrating CT concepts could:

- Improve student's analytical skills
- Provide a better understanding that programming is about solving the problem not just the code
- Improve women's attitudes and confidence towards programming
- Be used as an early indicator and predictor of academic success and that CT scores correlate strongly with general academic success

However, CT and research into it are still in the early stages, therefore long-term effects as well as additional benefits still need to be researched.

Challenges and Barriers

Several authors highlight that, when introducing CT in compulsory education, there is a need to adopt an inclusive approach addressing gender equity and special education needs.

The challenge of introducing CT in education is also how to evaluate learners' CT development. To assess CT, one requires a framework that would include evaluation of CT in three dimensions: learners' understanding of CT concepts, learners' CT practices and learners' attitudes (Kong & Abelson, 2019). To measure learners' understanding of CT concepts a number of methods have been used. Among those are both quantitative (e.g. test designs with multiple choice type questions in programming context, task or project rubrics) and qualitative (interviews, project analysis, reflection reports and observations). To assess learners' CT, one needs to consider a number of practices, e.g. the problem formulating practices, design practices and programming practices if they are envisioned. Measuring these by directly analysing their processes of designing and programming requires great effort. Some authors also suggest that learners' attitudes, such as interest in programming, should be included in the evaluation dimension. However, no single method measures learners' CT development effectively in the three dimensions.

To prepare teachers to develop logical thinking, algorithmic thinking, problem-solving and programming skills, professional development and support must be given (Kong & Abelson, 2019). Professional development should be appropriate to the needs of the teachers, and to the educational level; to prepare them to think about how they can teach their students.

Put into practice

CT has been integrated at all educational levels. Several countries embed CT across subject areas, particularly at primary level, while at secondary level CT is mostly included as a computing subject in its own right.

CT activities typically result in the creation of logical artefacts that can be run, tested against the original intentions, and can be refined accordingly. An extremely popular approach is the Computer Science Unplugged, whereby computing is taught without using technology (e.g. Curzon et al., 2014). Unplugged activities involve problem solving to achieve a goal and deal with fundamental concepts from Computer Science. The integration of physical activity in this process makes it lively and engaging. A typical example is the sorting network (Bell et al., 2012). Unplugged Computing can be seen as a first step of Computational thinking, which refers to the thought processes involved in expressing solutions as computational steps or algorithms that can be carried out by a computer.

Computer simulations are often used in science classes to support learning. Learners use simulations to explore phenomena, engaging in "what if" experiments and reflections while changing the values of the simulation's parameters. Also, Computational models are executable models that can be more easily tested, debugged and refined. Familiarity with CT & programming skills might enable students not only to use simulations, but also to modify the underlying computational model and design and implement their own model and get it to run a simulation (Lee et al., 2011).

Scalable Game Design (Repenning et al., 2015) advocates starting from a computer game construction project in order to reach computational modelling and simulation in STEM. Scalable Game Design builds on the motivational aspects of game design to foster a transfer of skills from game design and implementation to simulation and modelling via

Computational Thinking Patterns (CTP). CTP are design patterns acquired in constructing computer games and later transferred to the creation of STEM simulations.

Teachers' role in developing CT skills is very important. Since an iterative design process is a crucial aspect of CT, the importance of revision and working through mistakes, also teachers' modelling of their own CT processes and mistakes in front of the whole class has been highlighted as important (Kong & Abelson, 2019). Teachers play a key role in creating a collaborative learning environment and in scaffolding students' learning.

From the space organisational perspective, students are actively engaged in the creation, and investigation processes. They need to work together, however there is also an important space to learn independently - for which the develop zone is helpful. Also, the interaction between the teacher and students is an essential part of the learning while the teacher guides the students through the process. This interaction can be organised with intervals to give students time and space to work independently in groups.

An example of putting the approach into practice can be found here: Computational Thinking and Video

Conclusion

To sum up, CT is gaining popularity around the world, and CT is placed in school curriculum in various forms: integrated across subject areas, or as part of a separate computing subject. From the literature review it is clear that CT involves far more than offering a few hours of coding and there is a need for a holistic multi-disciplinary approach to teaching CT skills. Importantly, it is acknowledged that it is relevant to choose an approach that would provide children with the opportunities to generate interest, exposing children to developing CT skills starting at an early age though age-appropriate ways of playing. There is yet the necessity to develop a holistic approach to CT integration in education considering the essential aspects of assessment strategies and adequate teacher professional development.

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2.1.5 Robotics

Introduction

Humans find movement captivating and, in fact, have since always been fascinated by the inanimate brought to life. Children in special enjoy the possibility of bringing any object to movement, building upon the inherent pleasure. Control over objects, balance and the realization of a specific goal constitute elements that have been making the success of toys for many years. For the last fifty years, computers have allowed us to create virtual controlled objects, in many cases associated with attracting situations and narratives (e.g., Super Mario Bros videogame). A big step was made when children started to be able to control physical artefacts creating objects that are brought to life when animated by some computer program. These tangible programmable objects stand at the boundary between the inanimate and the animate thus bringing a new way of looking at our relation to the world. "Children realize that sophisticated behaviours can emerge from interactions of rules with a complex world, but at the same time, are still captivated by the wonder of a machine acting like a pet." (Martin, Mikhak, Resnick, Silverman and Berg, 2000, p.1).

For more than 40 years, many educational theorists (e.g., Papert, 1980) claim that robotics-based activities have significant potential to improve classroom teaching and to enhance learning quality. Educational robotics is currently seen as a powerful strategy to introduce Computational Thinking in early education through activities that involve students in systematic tasks implementing step-by-step sequences of code needed to program a robot in order to solve a given problem (Chalmers, 2019) or part of it. Furthermore, educational robotics constitutes a pedagogical approach to teaching and learning that inspires students to construct and program robots using specific languages that involve some kind of structure and logic. Papert (1991) constructivist principles, together with core patterns of computational thinking as proposed by Wing (2006) and apparent in some frameworks (e.g., Angeli, Voogt, Fluck, Webb, Cox, Malyn-Smith & Zagami, 2016; Atmatzidou & Demetriadis, 2016), provide a sound rationale for robotics-based learning activities.

Considering the current universe of programmable artefacts, the term robotics shows a somewhat limited scope in the field of tangible programming. Therefore, the designation of Programmable Tangible Objects (PTO) is used in this section in a wider scope that includes moving robots, drones and prototyping platforms based on microcontrollers.

Benefits

Programming a PTO encapsulates processes that use concepts such as abstraction, decomposition, pattern recognition, logical thinking and debugging thus providing many opportunities for cognitive development (Atmatzidou & Demetriadis, 2016; Chalmers & Nason, 2017). Additionally, achievements and outcomes that emerge from PTO-based computational activities, are linked to problem solving strategies, heuristics and procedures that include the problem definition and decomposition, the design or combination of algorithms, the testing and debugging of programs and the appreciation of the whole process of solving the problem.

Within a constructionist perspective, the use of PTO in education provides conditions for learners to define learning trajectories according to their own specific and concrete goals and thus creating opportunities for significant learning. The quality of learning comes from the nature of the activities and the structuring resources they use – the teacher, the peers and the artefacts available.

As teachers, we should look at PTO as resources that we can transform in learning objects in the sense that they offer possibilities to put concepts in action. Imagine the concept of proportionality – which is central in human mathematical culture – and the way it is usually exemplified in school taking situations from the everyday. Robotics and PTO in general offer the possibility of understanding the nature of proportional thinking through the observation, record and analysis of its effects in the behaviour of tangible objects that students can control and test non-proportional models to adapt to concrete situations. In doing this outside the restricted space of a computer screen, students' focus may be directed into complex ideas that become instantiated in the tangible robots. In a variety of disciplines, programming robots may be used within pedagogical approaches that take the form of learning scenarios where, for example, project-based learning and problem-based learning are applied. Additionally, robotics provides a deeper learning of technology itself.

Challenges and Barriers

Although the importance of the development of robotics-based learning activities is referred to in the literature, most of the reports are focused on the pupils. Studies that focus on teachers' competences or in the analysis of how robotics are integrated in the classroom activities, are still missing in literature (Seddighin & Sullivan, 2013; Geist, 2016). This means that it is not well established how to educate teachers to take advantage of robotics in teaching. Experience-based principles that teachers apply are the most common and should be valued in teacher training initiatives. But effective teacher education and support is needed for the appropriate and efficient use of robotics in education (Bers, 2020). This suggests the need to provide supporting aids that are crucial to improve teachers' self-efficacy and confidence in the use of this robotics technology in their pedagogical practices.

To overturn the possible difficulty of dealing with complex programming languages, the literature underlines the importance of considering the use of block-based programming environments and robotics both in primary as well as in secondary education. However, it is yet necessary to act intentionally in teacher education programs to turn effective and sustained the use of robotics in teaching.

It is crucial that the teacher understands the use of PTO as advantageous in certain circumstances and with specific purposes. In the general domain of robotics, the teacher may consider using different types of programmable artefacts with pedagogical potential. It should be noted that the level of conceptual difficulties while dealing with programmable objects depends not only on the type of PTO to be used, but also on the context and challenges that students face.

Put into practice

It is recognized that robotics has pedagogic value. Most of PTO constitute mediation artefacts that serve the acquisition of skills and the construction of complex concepts in many disciplinary domains. However, it is important that teachers understand some principles that support their options and teaching practices with robotics:

Principle 1: The teacher should have clear pedagogical objectives. The identification of specific learning objectives is crucial to guide the definition of the setting and the resources that the teacher makes available to implement the robotics-based learning scenario. The choice of a certain type of PTO should go according to the key objectives that the teacher puts forward.

Principle 2: Design the robotics-based learning scenarios for flexible activity. The teacher should understand the use of robotics as a way both to investigate and explore situations and problems, as well as to present and illustrate concepts and processes (e.g., mathematical models that simplify and allow the exploration of real world situations) created and developed outside the robotics domain.

Principle 3: The inclusion of robotics in learning activities should be pedagogically relevant and constitute a way to add value to the learning scenario. If innovation is understood as creating pedagogical value in students' activity, the presence of robotics within the learning scenario (through the choice of a specific PTO) should be based on a clear rationale showing why and what for it is needed.

Principle 4: For the choice of a specific PTO to be used in robotics-based activities, the teacher should go through a detailed exploration of its affordances and constraints. It may be the case that the learning scenario asks for rather simple robotics or, on the contrary, quite complex robotic functions. Therefore, the teacher should be aware of the different possible options and the associated possibilities for students' activities.

According to the purposes of the teacher and the nature of the learning scenario, there are a variety of possibilities that the teacher should be aware of. Piedade, Dorotea, Sampaio and Pedro (2019) present a rather complete cross-analysis of the core characteristics of 26 block-based and visual programming applications to be used in PTO. In relation to the hardware dimension of robotics, Pedro, Matos, Piedade and Dorotea (2019) show the range of existing possibilities according to the level of sophistication and the purpose of the learning scenario activities. For example, at an elementary level (adequate for very young children), the PTO typically shows a stable physical structure and reduced flexibility, without sensors or with very limited diversity of sensors, with predominance of pre-defined functions and reduced autonomy in interacting with the environment (e.g., BeeBot, Dash & Dot, Lego WeDo, Osmo, Ozobot, Zowi). In an intermediate performance standard, robotics-based activities use PTOs which are modular, with changeable physical structure and greater flexibility and customization, with diversity of sensors and the possibility of interaction between objects and with a certain degree of autonomy in the interaction with the environment through the multiple use of sensors (e.g., Bot'n'Roll, BQ PrintBot, Lego EV3, mBot, Picaxe). In an advanced level, prototyped PTOs are based on microcontrollers and microprocessors with a largely flexible and customizable physical structure, enabling the integration of external materials, with vast diversity of sensors and the possibility of interaction between themselves, with great autonomy in the interaction with the environment (e.g., Arduino, Bitalino, Raspberry Pi).

An example of putting the approach into practice can be found here: Robotics and Video

Conclusion

Robotics-based learning is a strategy that should be considered when designing learning scenarios both in primary and secondary classrooms as well as in teacher education. But it is important to note that the teacher should adopt principles to define the role of the PTO within the activities and the degree of freedom allowed by the device according to the learning objectives. The possibilities of choice of PTOs offer conditions to the teacher to have the right resources for specific pedagogic purposes and age level.

Even if some authors are cautious (e.g., Benitti, 2012) there is empirical evidence to support the effectiveness of educational robotics in some areas of schooling (e.g., mathematics, science) and framed by sound pedagogical proposals such as the very concept of learning scenario. However, it should be stressed that the success of the implementation of robotics-based learning scenarios heavily depends on the preparation of the teachers and on their pedagogical sensibility.

It is fundamental that the teacher makes a double movement – exploring the possibilities of a certain PTO starting from the object itself, together with a movement that brings the objectives of the learning scenario to be designed and the learning goals to be achieved. The balance between benefits and difficulties comes from the degree of engagement of students with the proposed learning scenario and the associated resources, and not from the PTO technology itself.

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2.2. Use of Play in Teaching and Learning

Introduction

It might be suggested that education is by tradition a non-game context. For ages playing games has been considered by many as the opposite of learning. There was the classroom and... the playground. Playing was also something that identified younger children. Once you got older you devoted your time to more serious occupations. However, effective educators have been using instructional strategies that resemble gamification for many years to support aspects of student engagement for the purpose of learning, for example using elements such as challenge, rules and goals (Rieber 1996; Rivera & Garden, 2021). Indeed, gamification is something that has existed and that teachers have been employing for some time, not using the term 'gamification'.

Times have changed and play has entered the world of the classroom. This doesn't mean that we integrate full, existing games. Gamification can be defined as the intentional use of game elements and game design techniques in non-game contexts, in this case education.

Games have typical ingredients like points, scores and the competition element. In many games you will also find rules, goals and challenges and sometimes you can move on to a next level. If you do well at the game you receive rewards, incentives or badges. Human interaction is another important attribute of a game: interaction can include both interdependent and competitive actions, and be mediated by technology. Assessment in the form of feedback is a key component of games and is largely driven by an understanding of levels of achievement (Bedwell et al., 2012). All these items can be integrated in learning scenarios to gamify learning.

Gamification can be added to analogue activities, but digital platforms offer additional features and options to transform a learning activity into a rich gamified experience.

Benefits

There is evidence that games and gamification can positively influence various aspects of the student experience such as the level of interest, intellectual intensity and intrinsic motivation through providing opportunities for autonomy, relatedness and competence (Rivera & Garden, 2021).

The most important benefit mentioned by all authors writing about gamification in education is that it increases students' engagement. The implementation of gamification principles can improve the attitude towards learning. If learning becomes a fun activity instead of a serious one, students will put their minds to work, no matter how hard they find the learning process to be. The secret behind this attitude is the complete lack of fear students get when in a gamified learning environment. (Top benefits gamification can bring to the classroom, 2018)

Gamifying learning brings both intrinsic and extrinsic motivation. Students will get personal satisfaction by being engaged in the activity and learn in a playful way. Extrinsic motivation comes from the recognition from others. In a gamified environment, it will come through gaining points or moving to a higher level. Leader boards can also give social recognition.

In traditional education, it is the teacher who estimates whether the students have reached a certain level and when it is the time to move on. Gamified learning offers opportunities for personalized learning and to move away from the one size fits all approach. Instant and individual feedback allows learners to follow their own rhythm and track and provides valuable information to the teacher.

Challenges and Barriers

The danger of gamification is that it is overused so that it becomes annoying. The way of applying gamification should match with the profile of the learners. Sometimes gamification is considered as patronizing, especially with older learners. Games and quizzes can be as too simple and repetitive, or too far-fetched.

Another point of criticism often given, is that gamification makes learning more superficial and becomes a goal as such. Quizzes focus on memorization instead of deep learning.

All is a matter of balance and engagement of students should go hand in hand with the quality of learning.

Put into practice

Gamification elements can be applied at all stages of the scenario and in all configurations regarding space and interpersonal relations.

When looking at the pedagogical ideas behind the learning zones we have **3 stages indicating the different options in how the teacher monitors the learning process**.

In the **Interact** zone the teacher guides and monitors the different steps of the learning scenario. When interacting with students the teacher can apply gamification techniques to get feedback from the students. Nowadays there are many apps where students can use their own device to take part in polls but also quizzes that include a gamification element. In the Interact zone the role of the teacher is mainly the one of quiz master and the students are the participants.

In the **Exchange** zone students work in groups and the teacher is at the side. Gamification elements can be an important motivator for group work.

In the **Develop** zone the students work independently without the direct supervision of the teacher. They can take quizzes in their own time and still have a social element through a leader board that many digital quizzes provide. Some apps provide the option to personalise learning where the result of a previous quiz automatically decides on the selection of the next quiz the learner must take.

The three remaining zones refer to the main stages of project work.

In the **Investigate** zone the students get familiar with the topic. Quizzes can be used as a way of identifying prior knowledge on the topic and raising student's interest. More importantly is the element of challenge that comes with the driving question of the task. Students need to develop strategies to reach the final goal and that is as such a very strong gamification element.

In the **Create** zone students showcase their learning after the investigation by creating a product. Teachers can insert gamification elements by inserting requirements for the task.

The **Present** zone concludes the cycle of the project. The final outcomes are shared and opened to peer feedback. If not a competition, at least there will be benchmarking and comparison which is in fact a way of gamification. Teachers can also add incentives at this stage.

An example of putting the approach into practice can be found here: Gamified Spatial Learning and Video

Conclusion

Applying gamification to education has proven to be very effective to increase the engagement of the learner. Learning activities can become in a way addictive and students often don't need additional encouragement to start or re-do the activity. Gamification also offers opportunities to explore different pedagogical concepts and to make learning more student centered.

The danger could be that gamification doesn't match the profile of the learner and that it is overused. The aim of applying gamification techniques must go beyond fun but should enhance quality of learning.

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2.3 Digital Storytelling

Introduction

Digital storytelling (DST) comes from oral storytelling, which is the art of telling a story through a three-fold partnership of mutual influences between a storyteller, a listener and a spoken story. It is linked with social life and related to the basic human need to find order, explanations and clarification.

DST extends storytelling into a narrative that blends voice, text and multimedia content through a creative process of meaning-making in which technological tools (such as computer, video camera, sound recorder) and semiotic codes (visual, linguistic, graphical, auditory) are combined in order to create, tell or retell a story (Lambert, 2010). It can be seen as an approach that facilitates disciplinary crossovers (Nuñez-Janes et al., 2017). Products of digital stories are video/audio projects that are produced through the use of digital media production software. The projects can be composed of a wide range of assets, including images, narrative voice overs, background music, video clips, texts. Digital stories are usually short, and the topics covered in digital stories can be extremely diverse, from personal tales to the recounting of historical events, from exploring life in one's own community to everything in between. However, it usually takes personal orientation and focuses on personal subjects.

Stocchetti (2016, p. 26) suggests that digital storytelling is not only about delivering stories with other means, but rather it is about changing the way meaning is created and changing the nature of the relationships based on those meanings. DST becomes a form of communication in itself.

Benefits

DST is an innovative narrative practice based on the creation of multimodal stories, which promotes communicative as well as digital competences. The pedagogical uses of digital storytelling are gaining popularity: in early childhood education (Yuksel-Arslan et al., 2016), in the primary classroom (Nixon, 2013), secondary education (Yang & Wu, 2012) and in higher education (Mirza, 2020; Villalustre & del Moral, 2014).

The integration of digital storytelling in the classroom aligns with the constructivist approach to teaching and learning which is directed towards student-centred pedagogy in which the student becomes the subject who critically reconstructs knowledge and engages in a reflective learning. It is also aligned with Vygotski's idea of learning as a cultural process.

DST promotes the utilisation of digital resources needed to communicate in the digital era (Robin, 2008), along with the ability to express oneself artistically. Literature suggests that DST can increase motivation and stimulates the skills involved in creating stories promoting technical and non-technical skills.

Within the socio-constructivist approach, the pedagogical applications of digital storytelling have been described as multiple: as a tool to acquire and share knowledge (Ohler, 2008; Lambert, 2010), as a powerful way to make abstract content more understandable (Robin, 2008) and as an effective teaching strategy to motivate struggling learners (Sadik, 2008). Others have shown that learning can be reinforced through identity reflection (Nixon, 2013).

Mainly, the successful integration of DST into education seems to be related to the opportunities that it brings to the classroom in terms of literacies and multimodal communication (Tanrikulu, 2020) through which students can better connect their insights on academic content with their identities. Educational applications of DST allow students to use their own voice and the expression of their personal ideas to facilitate their understanding. Using their own viewpoints gives students a sense of ownership because the stories that they tell include their feelings and are, therefore, expressed in a personal and meaningful manner (Lambert, 2010).

Challenges and Barriers

The actual assimilation of digital storytelling into students' curriculum may be complicated indeed. Problems include the time required to undertake such projects, the necessity of training for teachers; the importance of alignment with curricula goals; the need for clearly articulated goals and structures; the importance of awareness of the emotional sensitivities of students; the problems associated with access to digital hardware and software; and the challenges of appropriately assessing individual digital storytelling projects. (Clarke & Adam, 2010, 173).

Further, literature suggests that another challenge to integrate DST into education is to find developmentally appropriate and meaningful instructional technology tools. This is in particular challenging for early childhood and primary teachers. Teachers require training and time to choose appropriate software for children and integrate technology into the classroom. Importantly, students need the guidance and wisdom that teachers offer to help them use technology with care and to tell their stories with clarity. As Ohler (2016) argues that what is important is that teachers be advanced managers of their students' talents, time, and productivity.

The role of the teacher becomes even more important in introducing the DST pedagogy since it engages students in sense-making and triggers important emotional and cognitive functions. Ethical and privacy considerations should be given a particular attention.

Put into practice

Three broad types of stories can be distinguished: personal stories, stories that inform, and stories that retell historical events (Robin, 2008). DST pedagogy can be used to explore social issues and empower students in making educated, healthy choices since telling stories bring awareness. Garrety (2008) classifies digital stories into five categories: traditional, learning, project-based, social justice and cultural, and stories as reflective practice.

Importantly, digital storytellers are encouraged to own their insights, find their voice, and use it to tell their story. In addition to the personal aspect, planning the actual structure of the story is highlighted. This includes clarifying the story's meaning by the use of storyboards, thinking of the use of music. Mapping out a digital storytelling project's timeline and script is encouraged (Lambert, 2010).

Samantha Morra describes the process of developing digital stories (Figure 2) as the process that aligns with the concepts of six Learning Zones. She outlines the process:

> "First, all stories begin with an idea. It could be a topic of a lesson, a chapter in a textbook, or a question asked in class. Digital stories can be fiction or nonfiction. As a starting point, students can be asked to write a proposal, craft a paragraph, draw a mind-map. For this, they brainstorm and exchange ideas in the exchange zone. Next, students need to explore and learn about the topic in order to create a base of information on which to build a story. During this process, students learn to validate information as they delve deeper into a topic. At this stage, organization is very important. Mind-mapping, outlines, index cards, online note-taking tools are helpful. Students develop their stories. Next, the students are trying to write. Literary decisions come into play. They decide on the person, choose words. Good stories start with a good script. Storyboarding is the first step towards understanding sound and images. It is the plan or blueprint that will guide decision making about images, video and sound. Simple storyboards will just have room for images/video and the script. More advanced ones might even include room for transitions, and background music. Students use their storyboard as a guide, gather – or create – images, audio and video. Everything they choose will impact and set the tone for their digital story. Introduce concepts such as visual hierarchy, tone, and illustration. This is also a great time to talk about Copyright, Fair Use, and Creative Commons. Students should use this time to record

themselves reading their scripts. The next stage is to put it all together. This is where the magic happens – where students discover if their storyboard needs tweaking and if they have enough "stuff" to create their masterpiece. The final two steps are sharing and reflecting. Sharing online has become deeply embedded in our culture. Knowing that other people might see their work often raises student motivation to make it the best possible work that they can do. Finally, students need to be taught how to reflect on their own work and give feedback to others that is both constructive and valuable. Blogs, wikis discussion boards, and student response systems or polling tools can all be used to help students at this stage."

Figure 2. Eight Steps to Create Digital Stories (Samantha Morra, source: [8 Steps To Great Digital Storytelling – Transform Learning ~ written by Samantha Morra])

In relation to assessment of DST projects, standard rubrics have been widely used. Ohler (2008) offered nine considerations that provide a guide as well as specific artefacts that can be assessed by teachers: setting clear goals; the students' ability to present an orderly narrative; assessing students' planning; the presentation of content. Since many DST assignments involve group work, determining methods for assessing shared responsibilities and effective use of resources is vital. The timetable and script can be good group artefacts. Setting time aside in class to show the videos is helpful to support peer review of videos. Ohler also highlights the need to include some form of self-assessment.

An example of putting the approach into practice can be found here: Digital Storytelling and Video

Conclusion

DST intersects many of the active learning pedagogy tenets. It is a powerful tool to ignite student interest and invite students to become active producers of content and responsible reviewers of work produced by their peers. The students become involved in a creative exploration of new media in a more active way, and this represents a crucial aspect of developing critical media literacy. Importantly, DST can be a powerful form of self-expression that teaches students to create and critically evaluate new media artefacts.

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2.4 Innovative Approaches in Hybrid Learning Environments

Flipped Classroom Approach

Introduction

The flipped classroom is a rapidly growing phenomenon in schools and universities. A number of terms have been used to define the concept: 'inverted classroom', 'classroom flip'. Most of the studies on the flipped classroom have been performed in higher-education settings, and are either descriptions of how teachers have implemented the flipped classroom in their classrooms or are studies of the effect of using this method as compared to more traditional approaches (e.g., Herreid & Schiller, 2013). However, studies focusing on primary or lower-secondary education are scarce.

In search of a definition, Bishop and Verleger (2013) trace the phenomenon of the flipped classroom to digital technology and open access, and to a study by Lage, Platt, and Treglia (2000) and their term "inverted classroom," by which they mean "that events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa" (Lage et al. 2000, p. 32). Drawing on this, Bishop and Verleger (2013) elaborate on a definition of the flipped classroom "as an educational technique that consists of two parts: interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom" (p. 4). Thus, Bishop and Verleger (2013) stress the use of digital technology in the instructional activities outside the classroom. Primarily, the Flipped Classroom Approach (FCA) allows to transform the traditional lectures at school into video-recorded lectures to teach students key concepts of a particular topic as part of their homework providing class time for a more active and collaborative learning (Abeysekera & Dawson, 2015; Tucker, 2012). Further benefits and challenges are considered.

Benefits

Many theoreticians believe that the traditional model of lecture-based learning is becoming increasingly unappealing to the contemporary student and that a paradigmatic shift in pedagogy is needed to keep students engaged. FCA allows teachers to leverage video lectures at home to increase interaction with students in class advocating their own replacement with online instruction. Flipping the classroom can be an ideal merger of online and face-to-face instruction known as a "blended" classroom where more time is freed up to support student learning (Fulton, 2012; Springen, 2013). Apart from the teacher-to-student interaction, students interact with each other improving their problem solving skills, team work, creativity and innovation (Bergmann & Sams, 2012) without sacrificing content. Consequently, FCA facilitates the development of students as active learners who arrive better prepared to take a more active part in the classroom, since FCA allows more time for student activities as the teacher skips a part of the lecture. Within FCA, it becomes important to achieve better quality of activities and interaction in relation to the curriculum content. Importantly, students get the opportunity to think and ask questions during the class.

Absenteeism and homework completion (Alvarez, 2011) are additional issues associated with FCA. The class no longer falls behind in progress when either the teacher or students cannot keep up with the rest of the class. Moreover, in a FCA environment there are numerous opportunities for differentiated instruction as well as addressing multiple learning styles.

Furthermore, FCA can become the game-changer in relation to the use of technology as the approach enables a shift away from a textbook-based practice to a learning environment in which students use digital resources (Hulten & Larsson, 2018).

Challenges and Barriers

One of the key challenges represent limited access to technology outside of school which makes it difficult to attend the assigned videos. Moreover, Herreid and Schiller's (2013) study confirms that students may be resistant to come to class well-prepared and familiarize themselves with the new content prior to the class. Finally, creating videos is a time-consuming work that requires more intensive labour on the part of the teacher.

To better facilitate the students to make good use of the flipped learning, teachers are advised to explain the purposes and nature of flipped classrooms explicitly to the students in the beginning, assisting them to understand what they need to do, why these are necessary, and how they can complete them effectively and efficiently. Moreover, more scaffolding (e.g., reminders, consultations, parent support, and so on) at different stages of the flipped classroom is necessary. Reminders from time to time can help students of low self-discipline or poor time management skills remember to complete the pre-class self-learning.

Recent studies suggest that simply making materials available online or live streaming lectures, for example, does not guarantee a good learning experience (Strelan et al., 2020). Importantly, teachers themselves "add value" to the student experience. Engagement with the students during the entire cycle is crucial. For flipped classrooms, where organization is key to a successful activity for students (Bergmann & Sams, 2012), the act of flipping requires additional work and thought on both design of the content and student activities both online and in class and that motivated teachers therefore play an important role in the implementation of the flipped model (Strelan et al., 2020).

Put into practice

It is important to understand that FCA is not synonymous with online videos, the important point is the interactive activities done during time when teacher and students are face to face. It is not using video instead of teacher. It is not working unsystematically for students. It is not students spending all the course period in front of a computer. It is not a student studying alone.

FCA has four different elements. It is expressed that in order for teachers to achieve this approach, they have to take these four elements into consideration (FLN 2014). The properties of this approach which its English correspondence is “Flip” are explained like this by referring first letters:

- F (“Flexible Environment): It indicates provision of time and place flexibility of learning.

- L (“Learning Culture): In traditional teacher centred approach the source of knowledge is the teacher. In flipped classroom approach there is transition from teacher centred approach to student centred approach.

- I (“Intentional Content): Flipped classroom educators both think about how education is used to provide fluency and how they can develop cognitive understanding of students.

- P (“Professional Educator): The responsibility of flipped classroom educators is more than the ones using a traditional approach. Flipped classroom educators continuously observe students during the course, evaluate their studies and make feedback (Flipped Learning Network -FLN, 2014).

In order to apply the flipped classroom model, it is not necessary to be a professional video producer, it is possible to use any source that explains the subject (PDFs, recorded sounds, websites). Although Tucker (2012), expressed that flipped classroom educators are not needed to prepare their own videos instead they can reach lecture videos from internet sites such as Khan Academy, YouTube or Ted, most of the educators prefer to prepare their own videos. Some equipment that is necessary to form and broadcast lecture videos, are presented below:

Video forming equipment: Some of them are; Screen-Cast-O-Matic, Camtasia PC, TechSmith Relay, Office Mix, Adobe Presenter.

Video Hosting: After forming the video, it should be placed online for access of students. Some of video sites are; YouTube, TeacherTube, Screencast.com, Acclaim, GoogleDrive.

Video interaction Softwares: These are softwares that provide teachers with access to information such as which student watched which lecture video, how long he watched, how he answered the questions in the video. Some softwares that can be given as example are; EduCanon, EdPuzzle, Zaption, Office Mix, Verso, TechSmith Relay, Adobe Presenter, Google Apps for Ed.

Learning Management: As created videos can be sent to video hosting sites, they can be presented to access by using a learning management system (LMS). LMS should provide interaction with students. Moodle, Sakai, Blackkboard, VersoApp, Schoology, canvas, My Big Campus, Haiku Learning, Google Classroom can be given as examples for LMS.

The Role of Teacher

The most important factor in FCA is the role of teacher (Bergmann & Sams, 2012). This involves:

• Creating learning condition based on questioning

• Instead of transferring knowledge directly, being a guide to make learning easy

• Making one to one interaction with students

• Correcting misunderstandings

• Individualizing learning for each student

• Using technological equipments suitable for learning condition

• Creating interactive discussion conditions

• Increasing participation of students

• Sharing lecture videos as out of class activity

• Providing feedback by using pedagogical strategies

The Role of Student

In FCA the student transforms from passive receiver of knowledge to active promoter of knowledge. • Taking their own learning responsibilities

• Watching lecture video as before the course and preparing for the course by using learning materials

• Learning at his own learning speed

• Making necessary interactions with his teacher and friends, taking and giving feedback

• Participating discussions within class

• Participating team working

In traditional FCA students come to class by watching the lecture video of the previous night. The lesson starts with short questions and answers. If there are points in lecture that are not understood, they are explained comprehensively. In the rest of time, the teacher makes activities based on questioning and gives one to one support to students. In this kind of class structure, the lessons are always given as lecture video format out of course and the teacher never teaches the lesson directly. Accordingly, students are given the opportunity to learn by discussing. In FCA time is restructured. However, in the traditional approach teaching of the subject takes the most of course time (Bergmann & Sams, 2012). Class activity periods in the traditional approach of Bergmann and Sams (2012) and class activity periods in flipped classroom approach are given in Table 3.

Traditional Classroom	Time	Flipped classroom	Time
Warm up	5 min	Warm up	5 min
Homework checking of previous lesson	20 min	Answering lecture video questions	10 min
Teaching of new subject	30-45 min	-	-
Exercises or labarotory applications	20-35 min	Exercises or laboratory applications	75 min

Table 3. Comparison of within activity periods of traditional approach and flipped classroom approach

Chen et al, (2014) added 3 structures (Progressive Activities, Engaging Experiences, and Diversified Platforms) to four structures of flipped classroom approach (Flexible Environments, Learning Culture, Intentional Content, and Professional Educators) and formed Holistic Flipped Classroom (HFC) model. Holistic Flipped Classroom is a model that contains a total of home, mobile and physical classrooms synchronously. In contrast to traditional flipped classrooms where students are only supervised by instructors in the physical classroom and their home activities are not recorded and monitored, and hence cannot be analysed, all learning spaces in HFC are treated as classrooms because all of them are supported and monitored. By logging on to the platform in HFC, students can preview/review course lectures, attend synchronous class sessions, discuss course content with the instructor and with classmates, and offer reflections. All these tasks can be done seamlessly, and all their learning activities are recorded in the platform's system log. Figure 3 shows the working of the Holistic Flipped Classroom Approach.

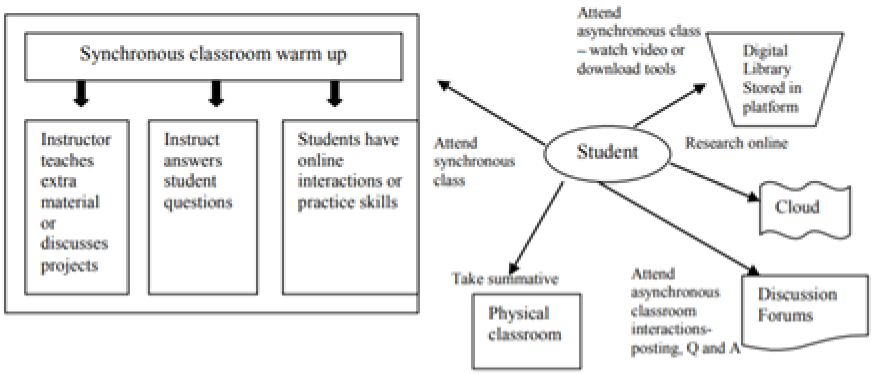

Figure 3. Holistic Flipped Classroom Approach

To achieve a higher level of student satisfaction with the FCA, literature suggests that engagement in class, as well as pre-class is important. Strelan et al. (2020) suggest that making pre-class engagement an explicit component, teachers communicate to students that student involvement is an expectation and is valued. Further, once in the classroom, student-centred activities—which predominate—lead to greater satisfaction with classes and teachers. In addition, group work appears to be a key driver of satisfaction with the teacher and classes. Active learning principles are central in the flipped learning paradigm. Put simply, the more students are encouraged to "do" and "apply" their knowledge to real-life problems in a collaborative manner, the more satisfying the experience.

An example of putting the approach into practice can be found here: [Flipped Classroom Appraoch]() and [Video]()

Conclusion

To conclude, the literature suggests that FCA requires significant changes in teaching and learning practice, and indeed can become a game-changer for pedagogical innovation and integration of ICT in education. What becomes clear is that teacher guidance forms a vital role in implementing the FCA. The videos out-of-class could be considered as an initial phase in the guidance, forming a basis for students' engagement with the tasks in class. During the development of collaborative participation in class, the teacher should play a proactive role in students' creation, clarification and meaning making of the key concepts. Although FCA can be beneficial for students' learning, it should be carefully designed to prevent this effect from being hampered by students' dissatisfaction. It is important to keep in mind that student satisfaction with a flipped approach extends beyond what happens in the classroom itself.

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2.5 Collaborative Approaches for Professional Development

2.5.1 Co-Teaching: multi-disciplinary approach

Introduction

It is understood as co-teaching when two or more teachers share the instruction of a group of students in a given learning space. The teaching approach taken by teachers is shared and includes common learning objectives, as well as a specific set of resources provided to the students (Chanmugam & Gerlach, 2013; Mackey, O'Reilly, Jansen & Fletcher, 2018). Historically, the co-teaching methodology dates from the 1960s, when the integration of students with special education needs (SEN) in regular classes started to become a more common practice. In the 1990s, with the advancement of research on co-teaching, its benefits were reported not only for students (with and without SEN) but for teachers as well, who indicated that, through co-teaching activities, they had developed new professional skills. Currently, co-teaching has expanded its field of action beyond inclusive education and appears as a good strategy for designing and implementing active learning pedagogies and multidisciplinary projects.

Regarding the terminologies adopted in literature to refer to co-teaching van Garderen, Stormont, and Goel (2012) identified four different terminologies: co-teaching, collaborative teaching, team teaching, and problem-solving in a teaching team (as shown in Table 4).

Terminology	Authors
Co-teaching	Murawski & Swanson, 2001; Scruggs, Mastropieri & McDuffieet, 2007
Collaborative teaching	Thousand, Villa & Nevin, 2007
Team teaching	Welch, Brownell & Sheridan, 1999
Problem-solving teams	Welch, Brownell & Sheridan, 1999

Table 4: Terminologies found in the literature for co-teaching (Stormont & Goel, 2012)

Benefits

Research has pointed out significant benefits regarding co-teaching (Murawski & Swanson, 2001). Welch, Brownell, and Sheridan (1999) refer to co-teaching as a teaching methodology that improves the teachers' professional performance due to the sharing responsibilities that are established between the teachers involved in this practice. Many other aspects are defended as beneficial to teachers' professional development in the practice of co-teaching; since the teaching process becomes an open and shared action it favors the emergence of reflection, considering that, when acting in partnership with a colleague, teachers are asked to analyze and redefine its own methods. Chanmugam and Gerlach (2013) refer to other benefits such as personal growth, better ways to conceptualize/structure teaching lessons and study plans, more compliance with the schedule defined for achieving the learning objectives, increment on the support provided to students and therefore to their academic success and skills development. Mackey et al. (2018) also attribute several benefits to co-teaching: a greater sense of teachers' effectiveness and well-being, greater ability to solve problems and reduction in teachers' feeling of isolation.

Specifically, in the case of novice teachers, co-teaching promotes a safe environment where they can experience new practice and define their own teaching style, as they have the support of a more-experienced colleague who offers critical feedback on his/her successes and mistakes. It is also quite useful in the case of innovative educational practices. If this is relevant in traditional contexts, it can be even more relevant in non-conventional contexts where innovative learning space design is being implemented and/or when the use of new technology is being explored.

Challenges and Barriers

Studies reveal some difficulties and challenges that must be overcome in a co-teaching scenario. Literature highlights the need for teachers to find time to learn how to develop co-teaching practices effectively, because although the methodology favours the creation of an environment conducive to professional development, managing students work in a co-teaching set is based on daily collaborative work between teachers, as well as on negotiation, mutual support and encouragement (Rytivaara & Kershner, 2012), which can be a challenging and time-consuming process even more between teachers teaching different school subjects like Arts, Languages and/or Natural Sciences.

The additional time needed for lesson planning and the difficult compatibility of schedule between fellow teachers are also referred to as co-teaching main barriers (Chanmugam & Gerlach, 2013; Scruggs, Mastropieri, & McDuffie, 2007). According to Chitiyo (2017), co-teaching also requires a greater number of resources available to teachers, openness to having another colleague in teachers' main territory (the classroom), and the reluctance of teachers to commit themselves to more demanding teaching practices.

For co-teaching practices to be successfully implemented, Mackey et al. (2018) also point out the need of having a supportive school leadership, as well as an institutional environment where professional development and pedagogical reflection are promoted.

Put into practice

One of the main difficulties that teachers face when working in innovative learning spaces where different learning zones are available is related to managing different students' work and to effectively provide on-time support to each and every one of them. Different groups of students are involved in different tasks, using different digital tools in different 'learning zones' and many of them require teachers' support at the same time. In a co-teaching scenario, having 2 or more teachers working together provides students with the extra support that might be needed. For example, when a group of students is working on a research assignment on the 'Investigate' zone and others are taking advantage of the 'Develop' zone for a deeper reflection about a topic, one of the teachers can help these groups on their working processes. Meanwhile, another teacher can provide technical support to other groups of students who are working on animation software in the 'Create' Zone or who are rehearsing their final presentation of their research project in the 'Present' Zone. Not only can teachers benefit from being on a higher ratio of teachers per student, but also they can make a more effective use of their different skills and divide responsibilities in managing students' requests for support according to their specific expertise. Starting to use innovative learning spaces can be a demanding process for teachers in the beginning, so initiating this accompanied by a colleague can make this process more secure and comfortable.

An example of putting the approach into practice can be found here: Multidisciplinary Co-Teaching and Video

Conclusion

In the current trends of modernization of school buildings and learning spaces, and for preparing schools for innovative pedagogical practices, the adoption of collaborative teaching methods can be a highly effective practice as it stimulates teachers mutual support and provides them a more secure context for exploring innovative teaching practices.

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2.4.2 Peer-Teaching

Introduction

In the context of teachers' professional development, the peer-assisted learning teaching model is a term that describes a set of educational strategies that is supported by learning through interaction among peers, who are most often pre-service teachers (Topping & Ehly, 2001). Historically, peer teaching programs have emerged in primary and secondary schools, with the aim of making learning more effective and focusing on students learning. The first successful experience of peer teaching was developed in 1798 by Joseph Lancaster, who at the time ran a school for students from economically disadvantaged contexts. In higher education, peer teaching was pioneered at Oxford and Cambridge universities, which followed the mentoring model where an assistant professor was mentored, in the beginning of his career, by a full professor. The best-known strategies of peer teaching are: discussion groups, student learning groups, learning cells and student mentoring (Goldschmid & Goldschmid, 1976). Peer teaching is more often referred in the literature as: peer-to-peer learning, peer tutoring, peer modelling, peer monitoring, peer assessment and cooperative teaching/learning (Topping, 2005; Topping & Ehly, 2001). It related strongly with Vygotsky ideas about scaffolding and his concept of Zone of Proximal Development, which refers to the difference between what an individual can do on his/her own and what he or she can achieve with guidance and encouragement from more capable peer(s) (Vygotsky, 1978).

Its wide range of applicability leads the concept of peer teaching to assume various terms in scientific literature (Cate & Durning, 2007). In Table 5, the most frequent terminologies and their respective areas of use are presented.

Examples of situations described in Literature	***Terminology***
Students working together to prepare for a test, rehearsing each other	*Peer assisted learning (PAL); Peer counselling; Cooperative learning*
Personal coaching by an experienced senior	*Near-peer tutoring; Near-peer mentoring*
Senior medical student rehearsing groups of junior medical students	*Near-peer teaching*

Residents as formally scheduled tutors or mentors	*Near-peer tutoring; near-peer mentoring*
Teaching assistants in lab classes or skills training; Residents as group teachers; Student-organized extracurricular voluntary group activities	*Near-peer teaching (within same level of training); Cross-level teaching (different level of training)*
Students taking turns to teach each other in small groups	*Reciprocal teaching; co-teaching*
Scheduled dyad tasks within lecture or small group sessions	*Peer assisted learning (PAL); Co-tutoring; Reciprocal tutoring; Teaching dyads; Peer monitoring*
Senior students counselling junior students in clinical clerkships	*Student mentoring; Peer modelling; Peer coaching*

Table 5. Frequent Terminology for Peer Teaching

Benefits

Peer teaching is increasingly gaining applicability, as it brings not only knowledge gains but also more emotional, social and cognitive benefits. Also, it should be noted that information and communication technologies are often used to support learning activities that are related to collaboration activities and peer teaching (Topping, 2005).

The affective aspects prove to be the best positive effect of peer teaching, since the proximity and trust between peers, where no position of authority can be found, promotes involvement, maintains enthusiasm, and builds feelings of loyalty and (co)responsibility (Topping & Ehly, 2001). Bragg and Lang (2018) also state that peer teaching establishes loyalty among peers and a constant constructive exchange of feedback. Peer-to-peer learning between teachers also contributes to overcome the barriers of curricular subjects' boundaries as it can be used as a professional development strategy between teachers from different school subjects.

For teachers, peer teaching raises confidence and enhances beliefs in their ability to be truly effective in making a difference in student learning, and it is further emphasized by teachers that their enthusiasm for peer teaching generates a greater commitment to redesigning their teaching practices hoping to improve students' results. Peer teaching leads teachers to a feeling of togetherness, better developed coping skills, and greater opportunities for self-reflection. In the perspectives of professional teachers involved in peer teaching activities comes to rely on a greater self-image and professional self-concept, which positively contributes to the creation of a learning environment where collaboration, mutual trust and respect are present (Nicholson, Rodriguez-Cuadrado & Woolhouse, 2018).

The benefits identified for teachers, when undertaking professional learning processes based on peer teaching, relate to the establishment of better relationships between the schools' teaching team, a more shared vision of schools' pedagogical principles, more sharing practices regarding learning resources/materials, a strong impact on the teachers' sense of belonging and ownership (Cockerill, Craig & Thurston, 2018).

It is also suggested that teachers that embrace peer-assisted learning and that also stimulates this process between their students, in addition to the expected knowledge gained, also promote the development of soft skills such as: communication skills, motivation, critical thinking and learning autonomy (Stigmar, 2016).

Topping and Ehly (2001) emphasize that in the implementation of peer teaching trainers/teachers' flexibility is fundamental in order to adapt and overcome some adversities that may arise, such as: lack of adequate furniture, unsatisfactory acoustics, schedule rigidity, and learners who prefer to assume a passive posture towards the proposed learning processes.

Challenges and Barriers

For the implementation of peer teaching, it is important that the trainer be aware that teachers will develop instruction to peers in a diverse way, so it is up to him/her to define the rules and norms for the process. In this sense, the risk to be avoided by the trainer is that the exposition of ideas that is inherent to peer teaching led to a poor understanding of the topic under study, due to the lack of proper knowledge (Knight & Brame, 2018). To avoid this, it is suggested that trainers i) carefully design training activities based on finding answers to challenging professional-related questions, and ii) clearly define the norms that will define the process of peer-teaching, as well as the processes of communication among peers/teachers.

Also about the challenges to be overcome in peer teaching, Carlson, Rees Lewis, Gerber and Easterday (2018) indicated that this methodology requires extra instructional resources and time, which must be very well coordinated by the teacher/trainer. At the same time, peer teaching increases the trainers' uncertainties around the topics and curricular contents that will be addressed. It is, therefore, recommended that he/she always prepared spare training content to meet emerging needs.

Stigmar (2016) presents some critical observations regarding peer teaching: the existing studies on this methodology lack clear results on its impact; the conclusions are mostly based on the view of researchers and derived mostly from the Natural and Physical Sciences. He calls for further research on the methodology, also stating that there are some uncertainties regarding its benefits in comparison to teacher/trainers' direct instruction.

An example of putting the approach into practice can be found here: Peer Teaching and Video

Conclusion

Peer teaching is increasingly gaining applicability in schools' daily practices, considering its benefits in knowledge gains as well as in emotional, social and cognitive competences developments. It should be noted that digital technologies are often used in teaching and learning activities where this methodology is used (Topping, 2005) along with other strategies where collaboration and group work are present. The use of peer-to-peer teaching can be a good methodology to support students' learning as well as it is to teachers' professional development. The issues that schools and their teachers have to deal with in the present days are becoming more complex, therefore the definition of solutions need to become more resourceful and innovative; this requires cooperation and mutual support between teachers, coordination of different strategies and out-of-the-box approaches. Therefore, working and training practices based on peer-to-peer learning should be incremented in teachers initial and continuous education.

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Conclusion

The present document aimed to present the literature review around the methodology of scenario-based learning, and to prove a thorough overview of the present research around the key innovative pedagogical approaches introduced in the FILS Project. It highlights the three-dimensional approach where pedagogical knowledge is aligned with technology and space, and invites careful consideration of interaction between technology, space and pedagogical practices.

The document addressed the key themes for learning scenario development in the FILS project. These are based on the key education trends which highlight the importance of creative and collaborative problem-solving, inquiry, application-based and multi-disciplinary syllabus, communication and social skills, digital literacy, personalised and inclusive learning environments, and the role of play. One approach connected to blended learning has been also presented to support practices in the hybrid learning environment.

In general, the pedagogical approaches presented in the document allow for flexibility in educational level and subject areas, and can be adopted by practitioners to suit their educational purpose. To conclude, the document is linked to 12 examples of FILS learning scenarios developed by the Partner Institutions for the FILS Project, and should be seen as an accompanying document to support the implementation of innovative practices.