FICTION

Functional ICT Instruction On the Net

Teachers' Guidelines

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1 Desirable Digital Competencies for Teaching Science

1.1 Desirable Digital Competencies for Teaching Science

In order to be able to use digital tools for teaching, it is necessary to have an understanding of how digital devices work. In TPACK terms [1], this is the Technological Knowledge dimension. At the basic level, this requires working knowledge of how to turn on and off equipment, how to start applications and how to use applications for word processing, calculation and so on. From this, it is then possible to learn other applications and finally start considering how to use them for teaching—the Pedagogical Knowledge dimension.

Several instruments have been developed for assessing teacher's skills according to the TPACK model [2], but for the Technological Knowledge dimension we want to bring forward the European Computer Driving Licence, a well-established syllabus for basic computer user skills, established in 1995 [3]. ECDL defines three sets of modules: Basic, Intermediate, and Advanced. The Basic set contains "Computer Essentials", "Online Essentials", "Word Processing", and "Spreadsheets". The Intermediate set contains fourteen modules covering many subjects, of which the most relevant for our purposes are "Presentation", "Information Literacy", "Computing" and, not least, "ICT in Education". Finally, the Advanced set contains "Advanced Word Processing", "Advanced Spreadsheets", "Advanced Database", and "Advanced Presentation".

In our opinion, the Basic set covers the necessary skills to be able to work with a computer at a basic level. The "ICT in Education" module is not aimed at any specific teaching tools, but rather aims to supply the knowledge about how to search for useful tools and what to look for—much like this set of guidelines.

The "Computing" syllabus covers introductory programming. It is not tied to any specific programming language, but goes through classic programming constructs, leaving it up to the course provider to present this in a concrete programming environment.

The downloadable syllabi are quite detailed, and it is easy to go through them to see which skills one has and which one lacks.

The "driving license" itself is awarded on passing the relevant tests. The tests contain both theoretical and practical items to be performed at a computer, demonstrating the ability to perform the tested operations, much as for a car driving licence.

The ECDL has the strength of being well-recognised and covering quite well what we feel to be the fundamental competencies, but currently the drawbacks are that the syllabi tend to assume a Microsoft Windows environment and that ECDL does not do either training or examination by themselves but delegates this to local educational organisations, where, at least in Sweden, interest has dropped in the last decade to the point that no course providers are available. It is of course possible to download the syllabi and design courses around them.

Once basic computer skills have been acquired, the teacher has to understand where to locate useful teaching tools for a given subject. Superficially, this is the application of "Online essentials" in order to either independently search for teaching tools, or participate in online teacher forums where information on tools are exchanged, but it also requires the ability to evaluate the quality and usefulness of potential teaching tools. Further, teachers should have a working understanding of Intellectual Property legislation,

as this affects what online material they can legally (re)use. Being aware of malware and thus avoiding downloading potentially infected software is also important knowledge.

The final level of skill is the use of suitable tools in an actual teaching situation. Digital tools should not be used merely in order to be modern, but contribute measurably to the teaching outcome.

Resources

[1] Herring, M.C., Koehler, M.J. and Mishra, P. eds. 2016. Handbook of Technological Pedagogical Content Knowledge (TPACK) for Educators. Routledge.

[2] Rosenberg, J. 2012. Assessing Teachers' TPACK. TPACK.ORG.

[3] ECDL Foundation: 2019. http://ecdl.org/ Accessed: 2020-02-03.

2 Teachers' self-assessment

Introduction

This chapter focuses on the teacher self-assessment, the process of making judgments about the appropriateness or effectiveness of one's own knowledge, performance, beliefs or effects, so that they can be improved o refined.

Self-assessment is a common formative evaluation process all teachers carry out to form their own personal, professional knowledge and skills, ant to assess their instructional effectiveness on a day to day basis. This process will only be carried through when the teacher assumes some responsibility for a practice, belief or outcome.

"We do not learn from experience…we learn from reflecting on experience."- John Dewey

2.1   Why It's Important to Evaluate Yourself as a Teacher

2.1.1   Introduction

The teaching professions face rapidly changing demands, which require a new, broader and more sophisticated set of competences than before. The teaching profession is built in a framework studded with changes and emergencies, acting on a level of complexity both internally and externally: the area of training necessities has been found to include cognitive, emotional, affective and relational needs. Moreover, it is evident how much the daily decision making takes place in unique situations and conditions, manifesting itself in a context that is difficult to foresee.

The "knowledge society" therefore requires to add to a purely theoretical or technical knowledge, a knowledge capable of analyzing and understanding the singular experiences that are being lived and deciding what actions to take. The context in which the teacher operates on a daily basis is constantly changing and contains heterogeneous cultures and existential conditions, requiring calibrated and attentive planning that not only concerns the field of knowledge, but the acquisition of skills capable of increasing the awareness of learning. The teacher is therefore consulted not only on a disciplinary level, increases the need to act with new tools and methodologies and to respond to emerging educational needs, which also pose questions to the personal value system and the thinking around one's own teaching. These changes, in fact, modify the didactic design and the teacher's own actions: from the one who proposes pre-established didactic models, to the professional who observes the learning environment and advances strategies aimed at achieving the set objectives. The practice of teaching, in fact, does not consist of a set of observable acts as action-reactions, but is the network of relationships within which choices and decisions are made in the light of the conduct, language, rules, objectives, strategies of "teaching knowledge" developed by the professional community.

Self-reflection and self-evaluation by the teacher therefore acquire a key role, because they are a process of judging the adequacy or effectiveness of one's own knowledge, performance, beliefs or effects, so that they can be improved or refined.

2.1.2   What is Self-assessment?

Teachers are individuals with specific prior knowledge and experiences and well as their own values and beliefs about teaching and learning. They teach in varying contexts related to curricula requirements and available infrastructure. This means that teachers have different professional development needs.

The use of self-assessment is intended assist in tailoring professional development to your circumstances and unique needs as self-identified.

Self-assessment also encourages to regularly reflect on the practice and may increase the motivation to improve whichever knowledge and skills you are focusing on where this reflection helps you to identify areas needing improvement.

In the several research studies, some teachers comment that using the self-assessment tool made them realise that they were not as knowledgeable as they had previously thought in certain areas for teaching and learning. Others were pleasantly surprised when their competence was compared with that of other teachers in their country and this increased their self-confidence.

Other studies found that some teachers were more able than others to accurately assess their own knowledge and skills and that accuracy has been increased engaging in some peer-to-peer assessment in addition to self-assessment.

Self-evaluation therefore means performing an exquisitely metacognitive operation: it means distancing oneself from one's ego, objectifying one's experience, one's experience, and looking at it as something else from oneself. The invitation to self-evaluation is therefore inserted in an overall perspective of strengthening the teacher's competences, unlike what it might appear. In self-assessment, the teacher is not only able to know his or her own potential and to intervene in any less developed skills, but he or she also learns a crucial skill. If self-assessment becomes a real habitus for the teacher, it is possible to count on systematic and progressive development in a professional learning to learn. The assessments made lead the teacher to identify a plan of action, precise actions to recover or consolidate in order to acquire a complete professional profile.

Online Resources

The definition of 'self-assessment tool' is adapted from:
http://publications.jrc.ec.europa.eu/repository/bitstream/JRC107466/pdf_digcomedu_a4_final.pdf (p. 92).

2.1.3   Teaching Specific Technologies

At times in a teacher's career, after many years of teaching, after learning how to manage the classroom, control bureaucracy and deal with students' families, it is easy to become complacent and do what you have always done. However, as a teacher, you must always evaluate yourself in order to continue to grow in the profession. Engaging in self-reflection is a way for teachers to continue to grow as professionals.
Prepare a professional development plan
Many teachers attend professional development courses throughout the year, not out of direct interest but in order to fulfill a bureaucratic duty, but the reality is that it is not the best approach to grow as a teaching

professional. If you want to grow as an educator, you need to conduct a self-assessment of your teaching and identify areas for improvement.

There are three basic components when planning your self-evaluation: a series of questions and goals, specificity and honesty when answering, and a pleasing environment:

1. Identifying questions and setting goals

Researchers suggests starting with two major questions:

- What has gone well?
- What hasn't gone so well?

To connect this to the teaching, it's a good idea to expand these and get specific. Teachers may choose to ask themselves questions like:

- What feedback have I received this year?
- When have I felt at my best in the classroom?
- How satisfied am I with my work/life balance?
- What were my best moments this semester?
- When have I most enjoyed teaching?
- When have I not enjoyed teaching?
- What skills have I learned or improved upon this semester?
- What has made me feel proud this semester?
- What has been a major win this semester?
- How have I overcome a particular problem?
- What are my strengths as a teacher and how are they developing?
- What are my current challenges as a teacher?

Then, set goals for the following semester by asking questions such as:

- What skills would I like to develop next semester?
- What would a "good Monday" feel like?
- What are two areas I want to improve on first?
- Who can I reach out to as a potential mentor?
- Who is a teacher I greatly admire and why?
- Where can I find free resources to develop my teaching?

2. Specificity and honesty

Try to be as specific as possible and focus on what you can change.

Similarly, be prepared to be honest with yourself. If your teaching has suffered, pinpoint why. If a particular class or student is not thriving, scratch away at the cause.

3. A pleasing environment

It's important not to feel rushed when doing a self-evaluation. Wherever you are, make yourself as comfortable as possible

What next?

It is possible to choose ending the process there and revisiting the thoughts at the following evaluation. How to move forward will depend on own current situation: how straightforward the evaluation was, what it learned about themselves, how challenging the set goals are, etc..

The process may even reveal a desire to experiment with other self-evaluation methods; such as having your class recorded, enlisting a peer review from a colleague, keeping a journal, or asking your students for anonymous feedback.

Self-evaluations are a valuable tool for teachers to identify challenging areas, highlight their wins, and step off the routine of lessons, assessments, and commitments.

The reality of the teaching profession is that each group of students entering the class has different strengths and challenges. In a single day, you may have four or five groups of students who are all distinctly different and need a slightly different approach to teaching. To do this successfully, you need to regularly engage in self-assessment so that you can grow the skills you need to face any challenges that students present to you.

Becoming a more effective teacher does not mean that a teacher passes more students or that a teacher raises their class average by so many points. To be more effective simply suggests that a teacher challenges and enlightens his/her students each and every day.

Online Resources

John MacBeath (2003). Teacher Self-Evaluation, International Handbook of Educational Research in the Asia-Pacific Region, 2003, Volume 11. ISBN : 978-90-481-6167-6
https://link.springer.com/chapter/10.1007%2F978-94-017-3368-7_53

Simon Borg and Adam Edmett (2019). Developing a self-assessment tool for English language teachers. Journal: Language Teaching Research, 2019, Volume 23, Number 5, Page 655. DOI: 10.1177/1362168817752543
https://journals.sagepub.com/doi/10.1177/1362168817752543

2.2 Teachers' Digital Competence

2.2.1 Digital Competence Framework

The teaching professions face rapidly changing demands, which require a new, broader and more sophisticated set of competences than before. The ubiquity of digital devices and applications, in particular, requires educators to develop their digital competence.

The 2030 Agenda for Sustainable Development recognizes that the prevalence of Information and Communication Technologies (ICTs) have a significant potential to accelerate progress, to bridge the digital divide and support the development of inclusive Knowledge Societies.

In this context, it is essential that teachers have the competencies to integrate ICT in their professional practice also need to be able to harness ICT to guide learners in developing Knowledge Society skills such as critical and innovative thinking, complex problem solving, the ability to collaborate, and socio-emotional

skills. Teacher training and continued on-going, relevant professional development for teachers are essential if benefits from investments in ICTs are to be realized.

Pedagogical digital competence has been investigated by numerous researchers. On International and national level a number of frameworks, self-assessment tools and training programmes have been developed to describe the facets of digital competence for educators and to help them assess their competence, identify their training needs and offer targeted training. Three major pieces of research have developed models of the competence that express a good level of maturity:

1) The ICT Competency standard for teachers defined by UNESCO, an attempt to identifying pedagogical digital competence to define a framework for teacher professional development and it articulates the competence in six areas (Understanding ICT in education, Curriculum and assessment, Pedagogy, ICT organization and administration, Teacher professional learning). It provides defines three levels: Technology literacy, related to technological competence, Knowledge Deepening, related to capacity apply technology in real problem solving and Knowledge Creation, related to the capacity to use technology to produce new knowledge.

2) The Technological Pedagogical Content Knowledge Model by Mishra e Koehler that identifies teacher's digital competence as the intersection of three primary forms of knowledge: Content (CK), Pedagogy (PK), and Technology (TK).

3) the European Framework for the Digital Competence of Educators (DigCompEdu) which will be discussed in the next paragraph.

Resources

Ilomäki, L., Kantosalo, A., & Lakkala, M. (2011). Which areas of digital competence are important for a teacher? Linked portal. Brussels: European Schoolnet (EUN), 1-12.

Krumsvik, Rune Johan.Situated learning and teachers' digital competence." Education and Information Technologies 13.4 (2008): 279-290.

Koehler, Matthew J., and Punya Mishra. "Introducing tpck." Handbook of technological pedagogical content knowledge (TPCK) for educators (2008): 3-29.

2.2.2 The European Framework for the Digital Competence of Educators (DigCompEdu)

The digital competence framework for teachers (DigCompEdu) is based on the work conducted by the Joint Research Centre (JRC) of the European Commission under the mandate of the Directorate General for Education, Youth, Sport and Culture (DG EAC).

DigCompEdu offers a coherent model that allows teachers and trainers to verify their level of "digital pedagogical competence" and develop it further. This model is not intended to replace the tools defined at national level, but to enrich and expand them. Its added value is to provide:
- A guide for the development of educational policies at various levels;
- A conceptual model that allows the different actors of the education and training system to

- create concrete tools, suitable to meet their needs;
- A common and coherent language to promote the discussion and exchange of good practices paperwork;
- A reference point for the Member States to validate the approach and completeness of the own tools and frameworks in this area.

The DigCompEdu framework is divided into six areas that focus on different aspects of the professional activity of teachers and trainers:

Area 1: Professional involvement and enhancement

Using digital technologies for organizational communication, collaboration and growth Professional

Area 2: Digital Resources

Identify, share and create digital educational resources

Area 3: Teaching and learning practices

Manage and organise the use of digital technologies in teaching processes and learning

Area 4: Evaluation of learning

Using digital tools and strategies to improve evaluation practices

Area 5: Enhancement of the potential of students

Using digital technologies to foster greater inclusion, personalisation and active involvement of students

Area 6: Fostering the development of digital competences of students

These stages and the logic of their progression are inspired by Bloom's revised taxonomy, that explains the subsequent cognitive stages of any learning progress well, from "Remembering" and "Understanding", to "Applying" and "Analysing", and finally to "Evaluating" and "Creating". Similarly, in the first two stages of DigCompEdu, Newcomer (A1) and Explorer (A2), teachers assimilate new information and develop basic digital practices; at the following two stages, Integrator (B1) and Expert (B2), educators apply, further expand and reflect on their digital practices; at the highest stages, Leader (C1) and Pioneer (C2), educators pass on their knowledge, critique existing practice and develop new practices.

The descriptors also relate to an educator's relative strengths and roles within a professional community. For example, within a team of educators, an Integrator (B1) is ideally suited to sourcing new ideas and tools, whereas the colleague at Expert (B2) level may be better at deciding how to go about implementing these; the colleague at Explorer (A2) level can best identify the possible problems learners may encounter in the use of the digital technologies involved, and the role of the Leader (C1) or Pioneer (C2) of the team would be to shape the project so as to seize the innovative potential of digital technologies in enhancing learning and empowering learners.

Help students to use digital technologies creatively and responsibly for activities concerning information, communication, content creation, personal well-being and problem solving.

By analysing and grouping the tools developed at international level, DigCompEdu is a scientifically sound framework that helps to guide policy and can be directly adapted to implement regional and national training tools and programmes. In addition, it provides a common language and approach that will help dialogue and exchange good practice across borders. The DigCompEdu framework addresses educators at

all levels of education, from early childhood to higher and adult education, including general and vocational training, special needs education and non-formal learning contexts. It aims to provide a general reference framework for DigCompEdu competence model developers, i.e. Member States, regional governments, relevant national and regional agencies, educational organisations themselves and public or private vocational training providers.

Online Resources

European Framework for the Digital Competence of Educators: DigCompEdu" by the European Commission's Joint Research Centre, EUR 28775 EN, ISBN 978-92-79-73494-6, doi:10.2760/159770, JRC107466, http://europa.eu/!gt63ch.

2.2.3   DigCompEdu Check-In: a Self-reflection Tool for Educators

The DigCompEdu Check-In questionnaire is a self-reflection tool developed by the European Commission, Joint Research Centre (JRC) in Seville.

This tool offers teachers in schools of all levels the possibility to identify their strengths and areas for improvement with respect to the use of digital technologies for teaching. It is a self-assessment questionnaire consisting of 22 questions that provides detailed feedback and useful suggestions, as well as indications to identify the main steps in the path of personal development towards innovative didactics.

DigCompEdu addresses educators at all levels of education, from pre-primary to vocational, higher and adult education. The focus of the framework is to support and encourage teachers in using digital tools to enhance and innovate education.

This self-assessment tool is based on the European Digital Competence Framework for Educators (DigCompEdu).

To encourage educators to use the DigCompEdu framework as a tool for their professional development, it was decided to couple CEFR levels with motivating role descriptors, ranging from Newcomer (A1) to Pioneer (C2).

These descriptors are intended motivate educators at all levels to positively appreciate their achievements and to look forward to expanding them further.

Online Resources

European Framework for the Digital Competence of Educators: DigCompEdu" by the European Commission's Joint Research Centre, EUR 28775 EN, ISBN 978-92-79-73494-6, doi:10.2760/159770, JRC107466, http://europa.eu/!gt63ch.

DigCompEdu Check-In Self-Reflection Tool: https://ec.europa.eu/jrc/en/digcompedu/self-assessment

3 Appropriate Tools for Professional Development

Introduction

This module is informed by the national policies and programmes for Professional Development of teachers, underlining the importance of digital competencies is underlined and suggesting some appropriate tools for Personal and Professional Development. In relation to tools for professional development for teachers, the following broad topics were researched:

External to the Schools – a full version of the research is available from Marie.Walsh@lit.ie
- National policies for Professional Development of teachers.
- Professional Development provided by education groups within each country, such as Professional Development Services for Teachers, Science Teachers Associations, Education Centres.
- Support from third level colleges and Professional Development provided by other national organisations, etc.

Internal to the Schools
- Specific tools and technologies used across the school.
- Student management specific tools and technologies, such as eportfolio, virtual learning environment, etc.
- General technologies available throughout the school such as Office 365, Google Classroom, etc.
- Teaching specific technologies such as screen/video capture, presentation tools etc.

Personal and Professional Networks and Instructional Design
- Mechanisms of collecting and curating appropriate resources.
- Rethinking pedagogies for the digital age.

3.1 National Policies for Professional Development of Teachers

3.1.1 Continuous Professional Development for Teachers in Ireland

Continuing Professional Development (CPD) for teachers in Ireland has greatly expanded since the early 1990s, although it is not yet mandatory.

Professional Development Service for Teachers
The PDST is key to the delivery of CPD and support to teachers in schools. Technology in Education is one of the many teams that comprise PDST teams to support teachers in line with DES strategies and ongoing curricular reform. Junior Cycle for Teachers (JCT) is a dedicated CPD support service that delivers appropriate high quality CPD for teachers, and the provides of effective teaching and learning resources.

The Teacher Professional Network Scheme (TPN) is a teacher organisation that affords professional peer

support to members. As well as offering certified continuing professional development courses, the universities and colleges of education also provide various shorter, non-certificate courses, and some engage in research and development courses with clusters of schools in their vicinity, with a strong professional development dimension.

Incentives for Participation in Continuing Professional Development (CPD) Activities
Teacher CPD is mainly voluntary. Where there is a curriculum change which necessitates CPD it may be viewed as mandatory although teachers cannot be directed to attend. Travel and subsistence are reimbursed according to Department rates and substitution may be provided depending on the course.
Certificates of attendance are provided in most cases, for example, to newly qualified teachers for attendance at workshops and also to primary teachers who attend 20 hour summer courses.
Some CPD opportunities are also available through the Irish Science Teachers' Association and conferences like ICT in Education.

Online Resources

Eurydice: National Policies Ireland – Teachers and Education Staff
https://eacea.ec.europa.eu/national-policies/eurydice/content/teachers-and-education-staff-36_en
This document describes the development of the teaching profession in Ireland and includes information on Continuous Professional Development.

Cosán – Framework for Teachers Learning
https://www.teachingcouncil.ie/en/Publications/Teacher-Education/Cosan-Framework-for-Teachers-Learning.pdf
This document contextualizes Cosán, the framework for professional development of teachers in Ireland

Teaching Council
https://www.teachingcouncil.ie/en/
Teacher Professional Network (TPN)
http://www.tpnetworks.ie/

Professional Development Service for Teachers (PDST)
https://pdst.ie/

PDST - Technology in Education
https://www.pdsttechnologyineducation.ie/en/

Irish Science Teachers' Association
https://www.ista.ie/

ICT in Education Conference
http://www.lit.ie/ict/default.aspx

3.1.2 Continuous Professional Development for Teachers in Italy

In Italy, the law 107/2015 on the reform of the education system has established that professional development (CPD) for teachers is compulsory, continuing and structural. The collective labour contract for school staff establishes that CPD is a both a right and a professional duty for teachers. Each school defines CDP activities, also establishing networks with other schools in their territory.

Training initiatives are generally not part of the teaching timetable and teachers have the right to participate as CPD contributes to the development of their professional life. Teachers are entitled to have five days with exemption from service during the school year to participate in training initiatives.

In order to help teachers in their CPD activities, law 107/2015 foresees a financial support delivered in the form of an electronic card. The card is personal and not transferable and is destined to permanent full-time and part-time teachers working in state schools, included teachers in their induction period. Every year, each teacher will receive a maximum of €500 for: purchasing books, magazines, hardware and software; attending courses offered by accredited bodies or by higher education institutions; attending cultural events (representations, movies, live events) and visit museums and exhibitions;

Carrying out activities consistent with the three-year educational plan of the school and with the National training plan. The sum is not considered an ancillary retribution and it is not taxable. Within the end of August of each year, teachers must send the statement of expenses for CPD activities to their school administration that make them available to auditors. In case of late or incomplete documentation, unjustified costs are recovered from the sum allocated to the teacher the following year.

Online Resources

Eurydice: National Policies Italy – Teachers and Education Staff

https://eacea.ec.europa.eu/national-policies/eurydice/content/continuing-professional-development-teachers-working-early-childhood-and-school-education-36_en

This document describes the Continuous Professional Development for teachers working in school education in Italy.

3.1.3 Continuous Professional Development for Teachers in Sweden

Incentives, supporting measures and funding for Participation in Continuing Professional Development (CPD) Activities

The municipalities have funds set aside for CPD of their staff and decide on its scope. The government can set aside funds for the municipalities and independent schools to support their work on developing the competence of teachers through extra funding to the Swedish National Agency for Education. The state shall, by means of the funds made available to the Swedish National Agency for Education, steer activities towards nationally important areas, taking into account that it is the principal organiser of the school that has the responsibility for implementing competence development.

A recent example is a programme called the "A boost for Teachers" (Lärarlyftet) where the Swedish National Agency for Education (Skolverket) publishes a catalogue of courses for teachers too choose from and which teachers can participate in while retaining 80 per cent of their salaries.

Online Resources
Eurydice: National Policies Sweden – Teachers and Education Staff https://eacea.ec.europa.eu/national-policies/eurydice/content/teachers-and-education-staff-79_en This document describes the development of the teaching profession in Sweden and includes information on Continuous Professional Development. **Continuous Professional Development for Teachers in School Education** https://eacea.ec.europa.eu/national-policies/eurydice/content/continuing-professional-development-teachers-working-early-childhood-and-school-education-76_en This document gives more detail on the mechanisms for CPD in Swedish schools.

3.2   Equipping Teachers for Professional Development

3.2.1   Strategies for Professional Development

Continuing professional development (CPD) is accepted as an integral part of teacher education because only a continuum of learning and training assures a high level of expertise and enables the teachers to keep their professional skills and knowledge up-to-date. This is particularly pertinent when it comes to the use of ICT in education.

National CPD support services like the Irish Professional Development Service for Teachers – Technology in Education section are supporting and promoting the use, application and development of digital content which is relevant to the Irish curriculum through the on-going development of Scoilnet as a portal site, which provides access to thousands of teacher reviewed resources relevant to the Irish curriculum through the evaluation and development of digital materials and resources (including software) and project partnerships; and supporting the innovative use and integration of ICT in schools through pilot projects.

In Italy, INDIRE, the national board for educational research and teacher development has a rich resource bank for professional development related to the use of ICT in schools, including over 1 400 text or multimedia resources (of which over 10 hours of video tutorials), many of which introduce subject-specific uses of ICT. Training is often in blended (face-to-face and online) mode, combining preparatory face-to-face sessions with online activities and materials that are specific to subjects and grade-levels and linked to curricular contents and distance tutoring.

The Swedish Government digitisation strategy for compulsory and upper secondary schools focuses on understanding digital tools and media, digitisation's impact on society and individuals, ensuring critical and responsible behaviour, problem solving and translating ideas into action using digital technology. Programming is taught through mathematics and digital skills in general through mathematics, civics, Swedish and technology.

Online Resources
European National Policies in Digital Education https://eacea.ec.europa.eu/national-policies/eurydice/sites/eurydice/files/en_digital_education_n.pdf

TALIS Report 2018
https://www.oecd-ilibrary.org/sites/c2037a8f-en/index.html?itemId=/content/component/c2037a8f-en

Scoilnet
https://www.scoilnet.ie/go-to-post-primary/
Includes a section of resources for STEM https://www.scoilnet.ie/stem/

Digital Strategy and ICT in Education in Italy (An assessment).
http://www.oecd.org/education/ceri/Innovation%20Strategy%20Working%20Paper%2090.pdf

INDIRE Italy
http://www.indire.it/en/activities/current/

Education and Training Report Sweden
https://ec.europa.eu/education/sites/education/files/document-library-docs/et-monitor-report-2018-sweden_en.pdf

"Same but different? An examination of Swedish upper secondary school teachers' and students' views and use of ICT in education"
https://doi.org/10.1108/IJILT-09-2016-0043
Lindberg, O., Olofsson, A. and Fransson, G. (2017), International Journal of Information and Learning Technology, Vol. 34 No. 2, pp. 122-132.

3.2.2 Tools and Technologies Used across the School

Student management specific tools and technologies

As a majority of materials created and used by staff and students in their academic work is now digital, the e-Portfolio has emerged as an authentic and effective option, allowing portfolio owners to curate and manage their digital footprint and identity across multiple thresholds, using a variety of media. E-Portfolios can foster a mode of learning and assessment that is student-centred and promote critical thinking and reflection by putting an onus on students themselves to demonstrate how their work meets the stated learning outcomes of a programme of study. E-Portfolios can be used to demonstrate competencies including Documentation of skills and learning; Recording and tracking development within a program. For the teacher they can also be useful tools for planning educational programmes and evaluation and monitoring of student performance.

The E-portfolios can be a component of the Virtual Learning Environment (VLE). However, the VLE is a valuable tool that forms a repository of course materials, assignments, assessments that is accessible and continually evolving at the discretion of the teacher. VLEs are also known as Course Management Systems (CMS) and Learning Management Systems (LMS), among other names. A Virtual Learning Environment (VLE) is a system for delivering learning materials to students via the internet. These systems include assessment, student tracking, and collaboration and communication tools. They can be accessed both in and outside school, meaning that they can support students' learning outside the classroom at any time.

There are different types of VLE, which all work slightly differently but have the same function and can deliver the same learning materials. The VLE will fit into any one of the following three categories:

Off-the-shelf, e.g. **Blackboar**d; Open source (often free to use and adapt but support is charged for), e.g. **Moodle**; Bespoke (developed by schools and institutions for their own individual needs).

An emerging VLE with integration of other tools is **itslearning**.

General technologies available throughout the school

These include packages such as Office 365 and Google Classroom.

Teaching specific technologies such as screen/video capture, presentation tools, etc. are also worth mentioning.

For many teachers undertaking professional development at conferences, workshops, online seminars, and one-on-one coaching sessions, there are many online CPD tools created by teachers or which have teachers on their advisory boards.

Online Resources

educatorstechnology

https://www.educatorstechnology.com/

This website has a huge range of tools for teachers. It is indicative of the need to choose what works best for the individual teacher and remember that it is impossible to use all technologies.

ePortfolio

https://www.teachingandlearning.ie/project/an-eportfolio-strategy-to-enhance-student-learning-assessment-and-staff-professional-development/

A project to develop and ePortfolio framework for Ireland is described here

Virtual Learning Environments

More detailed information can be found on the Open University site (a world-leader in delivering courses utilising VLEs) https://global.oup.com/uk/orc/learnvle/

Blackboard: www.blackboard.com

Moodle: www.moodle.org

itslearning: https://itslearning.com/global/

Office 365

https://www.office.com/

Students and educators at eligible institutions can sign up for Office 365 Education for free, including Word, Excel, PowerPoint, OneNote, and now Microsoft Teams, plus additional classroom tools. Teachers need a valid school email address.

Google Classroom - a free web service, developed by Google for schools, that aims to simplify creating, distributing, and grading assignments in a paperless way. The primary purpose of Google Classroom is to streamline the process of sharing files between teachers and students.

https://support.google.com/edu/classroom/

3.2.3 Teaching Specific Technologies

This list features several web tools for teachers keen on integrating technology into their instruction and work routine. There are many web platforms that are educationally focused including the following:

Google drive: a suite of productivity tools that works across different devices. Google Drive provides 15 GB of free storage. It enables the creation of stunning presentations, collaboration on a document, drawing or design spreadsheets for classes,

Dropbox: al cloud-based storage platform that allows saving and storage of documents and PDFs and sharing with others.

Evernote: powerful web tool that can be used to make notes, bookmark webpages and many more. Evernote is free and works across different devices mobile and web based.

Socrative: a smart student response system that empowers teachers to engage their classrooms through a series of educational exercises and games via smartphones, laptops, and tablets.

Edmodo: a safe and easy way for classes to connect and collaborate, share content, and access homework, grades and school notices.

Prezi: a cloud-based presentation tool that allows creation of presentations embeddable in different websites and blogs

ThingLink: a web tool that lets you create interactive images that can contain links, videos, presentations and many more

Flipboard: a platform that can be used to collect, and curate favourite stories or articles and read them in a magazine like format.

Edutopia: the motto or this platform is "Empowering and connecting teachers, administrators, and parents with innovative solutions and resources to better education."

Google in Education: platform created by Google with comprehensive information about using Google products in education.

Wevideo: an online video creation platform, providing video editing, collaboration, and sharing across any device - mobile, tablets, laptops & PCs.

Poll Everywhere: Audience response system that uses mobile phones, twitter, and the web. Responses are displayed in real-time on gorgeous charts in PowerPoint, Keynote

Piktochart: infographic making tool that is free and very easy to use, as well as providing already made

templates to use.

Edshelf: web tool to curate, organize and share web content.

Diigo: a social bookmarking website which allows signed-up users to bookmark and tag web-pages. Additionally, it allows users to highlight any part of a webpage and attach sticky notes to specific highlights or to a whole page

Mentimeter: Enables students to contribute to presentations with their smartphones and show the results live.

Panopto: allows teachers to record, live stream, manage, and share videos that can enhance student interaction with the VLE.

Online Resources

Google drive: https://www.google.com/drive/

Dropbox: https://www.dropbox.com/

Evernote: https://evernote.com/

Socrative: https://socrative.com/

Edmodo: https://new.edmodo.com/

Prezi: https://www.prezi.com

ThingLink: https://www.thinglink.com/

Flipboard: https://flipboard.com/

Edutopia: https://www.edutopia.org/

Google in Education: https://edu.google.com/

Wevideo: https://www.wevideo.com/

Poll Everywhere: https://www.polleverywhere.com/

Piktochart: https://piktochart.com/

Diigo: https://www.diigo.com/

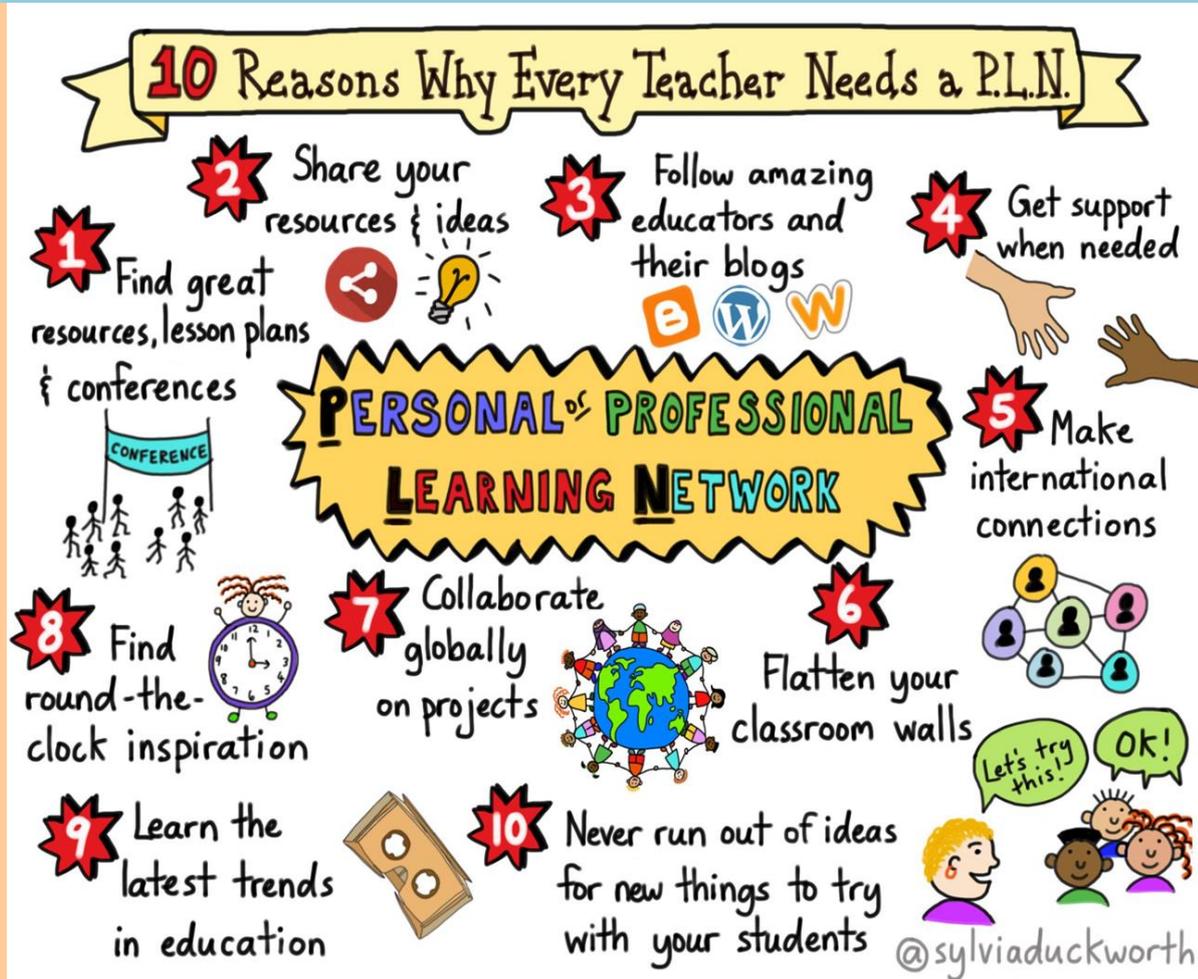**Mentimeter:** https://www.mentimeter.com/features

Panopto: https://www.panopto.com/

3.3 Developing a Personal or Professional Learning Network

3.3.1 Personal or Professional Learning Network and Instructional Design

This graphic by Sylvia Duckworth captures many of the advantage of Personal and Professional Learning Networks. The day to day burden of timetabled teaching hours as well as the need for preparation, assessment, evaluation and feedback is a driver for organisation of CPD. Digital competency opens a rich opportunity for sharing, collaboration, support and inspiration to enhance teaching and learning.

There is no substitute for actual attendance at conferences but many of these (especially where they are related to ICT and Digital competencies) are available for on-line or remote attendance. Using social network tools like Twitter allows a high level of connectivity and collaboration.

Learning Design has emerged as a means of providing practitioners with the guidance and support they need to harness the potential of technologies. It can also be used by teams of practitioners to co-design learning interventions.

Learning Design

Beetham and Sharpe (2019) in the third edition of their text *Rethinking Pedagogy for a Digital Age* examine contemporary issues in the design and delivery of effective learning through a critical discussion of the theoretical and professional perspectives informing current digital education practice. This third edition has been thoroughly revised to address socio-cultural approaches, learning analytics, curriculum change, and key theoretical developments from education sciences. Illustrated by case studies across disciplines and continents for a diversity of researchers, practitioners, and lecturers, the book is an essential guide to learning technologies that is pedagogically sound, learner-focused, and accessible.

One of the advocates of new methods of Learning Design, Grainne Conole, has produced a framework - *The 7Cs of Learning Design.* This framework illustrates the key stages involved in the design process, from initial conceptualisation of a learning intervention through to trialling and evaluating it in a real learning context. The framework implements the following stages:

1. **Conceptualise**: What is the vision for the learning intervention, who is it being designed for, what is the essence of the intervention, what pedagogical approaches are used?

2. **Capture**: What Open Educational Resources are being used and what other resources need to be developed?

3. **Create**: What is the nature of the learning intervention the learners will engage with and what kinds of learning activities will the learners engage with?

4. **Communicate**: What types of communication will the learners be using?

5. **Collaboration**: What types of collaboration will be learners be doing?

6. **Consider**: What forms of reflection and demonstration of learning are includes? Are the learning outcomes mapped to the activities and assessment elements of the learning intervention?

7. **Consolidate**: How effective is the design? Do the different elements of the design work together?

Collaboration with other teachers is important and sharing is possible through relevant social media sites. For example Ireland has a weekly teach-meet on Twitter through @EdChatIE and inevitably this will provide links to other events or collaborations like TechWeek Ireland.

Online Resources

Sylvia Duckworth

https://sylviaduckworth.com/

This award-winning Canadian teacher has produced a wealth of resources including Sketch Notes, an example of which is included in Paragraph 1.

Beetham, H. & Sharpe, R. (2019) Rethinking Pedagogy for a Digital Age, 3e, Routledge, London, ISBN-13: 978-0815369264 can be purchased on-line but earlier versions are available on-line, e.g. at
https://www.taylorfrancis.com/books/e/9780203961681/chapters/10.4324/9780203961681-9

The 7Cs of Learning Design – a new approach to rethinking design practice. Gráinne Conole, University of Leicester
https://www.lancaster.ac.uk/fss/organisations/netlc/past/nlc2014/abstracts/pdf/conole.pdf

3.3.2 Professional Development Tools Created by Teachers for Teachers

For many teachers undertaking professional development at conferences, workshops, online seminars, and one-on-one coaching sessions, there are a lot of online CPD tools created by teachers or that have teachers on their advisory boards.

TeacherCast

Get a variety of PD resources here, from podcasts to screencasts to articles and more.

BAM! Radio Network

Listen to a vast network of education podcasts from notable educators.

TeachBoost

Further your instructional development with this evaluation and feedback platform.

Professional Development

This one is curated by professional development specialist Shighla Jacks and currently displays 12 working links.

PDST in Ireland also has listings of CPD opportunities. These range from short courses to in-school training sessions.

European collaborations offer CPD tools and courses. Among these one of the most widely known is Scientix, which promotes and supports a Europe-wide collaboration among STEM (science, technology, engineering and maths) teachers, education researchers, policymakers and other STEM education professionals. In its first stage (2009-2012), the project built an online portal to collect and present European STEM education projects and their results, and organised several teacher workshops.

The goal of the second phase of the Scientix project (2013 – 2015) was to expand this community to the national level. Through a network of National Contact Points (NCPs), Scientix reached out to national teacher communities, and contributed to the development of national strategies for wider uptake of inquiry-based and other innovative approaches to science and maths education.

This activity is continued in the third stage of Scientix (2016-2019).

Scientix includes a repository of relevant projects and their outcomes. One example is ICT for IST which offers new approaches to teacher training in the use of ICT in the STEM classroom supported by instructional material, online resources and demonstration videos.

Online Resources

Professional Development Tools Created by Teachers for Teachers

https://www.educatorstechnology.com/2015/07/professional-development-tools-created-by-teachers-for-teachers.html

TeacherCast

https://edshelf.com/tool/teachercast/

BAM! Radio Network
https://edshelf.com/tool/bam-radio-network/

TeachBoost
https://edshelf.com/tool/teachboost/

Professional Development
https://edshelf.com/shelf/shighla-professional-development/

PDST Technology in Education CPD
https://teachercpd.ie/

Scientix
http://www.scientix.eu/about

ICT for IST
http://ictforist.oeiizk.waw.pl/

3.3.3 Building a Personal Learning Network

Social Media allows teachers to connect with colleagues all around the world. It also allows for sharing of experiences and building of Personal and Professional Networks. Some of the more popular media include:

- **Twitter**: social networking platform that allows teachers to create Personal Learning Networks and connect with other educators from all around the world.
- **Tweetdeck**: allows creation of a custom Twitter experience.
- **Facebook Education Group:** This Group is an interactive space linked to the official Facebook Education Page - a professional learning community for educators to come together to share, learn and inspire one another. In this Group, educators from across the globe can gather in a safe space to share ideas to better themselves and their field, explore new ideas with new peers and collaborate to tackle challenges.
- **Pinterest:** a visual bookmarking website that allows you to bookmark, organize, and curate digital content into pinboards that can be easily shared with others.
- **Paper.li**: a tool to use to turn the feeds of Twitter, Facebook, or Google Plus into a neat looking magazine.
- **Skype:** Voice-over-IP service that allows individual and group calls and can be used to host hangouts and tutorials.
- **TED Ed**: platform allows users to take any useful educational video, not just TED's, and easily create a customized lesson around the video. Users can distribute the lessons, publicly or privately, and track their impact on the world, a class, or an individual student.

- **Scoop.it**: web tool that lets curation of content in the web and organize it into boards similar to Pinterest boards.
- **Edshelf:** web tool to curate, organize and share web content.
- **Slideshare:** world's largest community for sharing PowerPoint, OpenOffice presentations, Keynote, PDF and infographics.
- **Pearltrees**: a social library that allows cultivation of interests with collection, organization and sharing capabilities.

Online Resources

The 31 Educational Web Tools Every Teacher Should Know about
https://www.educatorstechnology.com/2013/12/the-31-educational-web-tools-every.html

Twitter
https://twitter.com/

Tweetdeck
https://tweetdeck.twitter.com/

Facebook Education Group
https://education.fb.com/

Pinterest
https://www.pinterest.ie/

Paper.li
https://paper.li/

Skype
https://www.skype.com/en/

TED Ed
https://ed.ted.com/

Scoop.it
https://www.scoop.it/

Edshelf
https://edshelf.com/

Slideshare
https://www.slideshare.net/

Pearltrees
https://www.pearltrees.com/

4 Appropriate Digital Tools for Teaching Science

Introduction

It is important to have one's priorities right when deciding on what tools to use in teaching. While the curriculum may stress the importance of digital literacy and the use of modern tools, the important thing is to concentrate on the pedagogical dimension. While, e g, using presentation software and computer projection may simplify the production and updating of slides, it does not in itself imply any pedagogical changes, and thus not necessarily any improved learning by the pupils. The aim must be the use of digital tools in teaching to allow learning that is otherwise difficult to achieve, this includes, but is not restricted to:

- Interactive animations and visualisations of processes or objects;
- Self-directed studies by pupils;
- Support for students with reading/writing disabilities.

We can further divide the types of tools as:

- Tools used by the teacher only. These are for example animations, demonstrations, and such.
- Tools that are shared by the class, and used under teacher supervision. This may for example be Smartboards used in turns by pupils and teachers, or video conferencing software to communicate with people elsewhere.
- Tools used independently by the pupils. This may be the use of search engines, or word processors, but also interactive simulations, modelling software, or programming environments.

Tools that are used mostly unsupervised have the problem that while they are useful for learning, they are also a cause for distraction, or to be precise, the devices the tools run on—computers and mobile phones—run all kinds of other software that can be distracting even if the tool itself is not. Avoiding these distractions requires a level of self-discipline that pupils do not necessarily have, so may require closer supervision by the teacher.

We list here a set of tools that we have tested within the project, with suggestions on how to use them and in what context.

4.1 Animation tools

Animations are useful to make processes easier to understand. While a teacher may prepare an animation to show the pupils, it is a useful lesson for the pupils to prepare an animation of their own to develop and show their understanding of a process. Tools for creating animations need not be very complex. Microsoft PowerPoint features functions for animating elements on a slide which are easy to apply.

We have also used Stop Motion Studio to let students prepare short animations by recording physical objects.

Simple video editing tools, such as QuickTime Player can also be used to create animations from recorded or pre-existing video material.

Online Resources
Slide Presentation Software, PPT - Microsoft PowerPoint: 2020 https://products.office.com/en-ww/powerpoint Accessed: 2020-02-07. **Stop Motion Studio - Let's Make a Movie** https://www.cateater.com/ Accessed: 2020-02-07. **QuickTime - Official Apple Support: 2020** https://support.apple.com/quicktime Accessed: 2020-02-07.

4.2   3D-modelling tools

SketchUp and Tinkercad are tools for 3D modelling that are run directly in a web browser. They thus do not require download and installation of software, but they do require registration of the users. (A shared class account may be the easiest way to handle this.)

Modelling can be used in mathematics for training geometry. Being able to easily modify the size of a body and immediately see the resulting difference in surface area and volume is an advantage.

Modelling can also be incorporated in craft classes in order to plan the objects to be produced.

Learning the basics of the tools is achievable in the course of a lesson.

Online Resources
3D Design Software | 3D Modeling on the Web | SketchUp https://www.sketchup.com/page/homepage Accessed: 2019-05-09. **Tinkercad | Create 3D digital designs with online CAD** https://www.tinkercad.com/ Accessed: 2019-05-08.

4.3   G Suite

The G Suite by Google contains collaborative web-based versions of office software. These have the advantage that they allow a full class to work on a single document, while enabling a teacher to keep track of the progress of individual pupils. We have used Sheets to prototype CoPuzzle, a shared quiz where each pupil by answering correctly reveals a part of a picture. In this case the students simply use Sheets as a convenient tool for input, whereas the developer had a platform for easy development of a collaborative application. Sheets unfortunately do not have the powerful animation features of PowerPoint.

Online Resources
G Suite: Collaboration & Productivity Apps for Business https://gsuite.google.com/ Accessed: 2020-02-06. **Google Sheets: Online Spreadsheets for Business | G Suite** https://gsuite.google.com/products/sheets/ Accessed: 2020-02-07.

4.4 Programming tools

Programming is usually part of the mathematics or technology subjects. There is a range of devices and tools that can be used to teach programming concepts. Bee-Bots are little turtle-shaped robots, which can be programmed, by pressing buttons on their backs, to move a given number of steps forward, turn to the side, etc. These robots are simple enough that they can be emulated by letting pupils perform the same actions over a taped grid on the floor.

Arduino is a small computer on a board, which is available from many electronics stores as a kit with the board and a number of electronic components, in the form of sensors, lights, etc. The board can be programmed in a language similar to C++. Using the kit requires an introduction to electrics, but after that many exercises can be done even without programming. Programming an Arduino usually does not require more complex programming constructs than scalar variables, selection and loops, and can be demonstrated relatively quickly.

Scratch is a graphical programming environment which makes it easy to create simple animations and games. The use of virtual shaped blocks as a frame for the program, makes for simpler syntax and helps avoid formal errors when programming.

Online Resources
Arduino – Home https://www.arduino.cc/ Accessed: 2019-05-08. **Scratch - Imagine, Program, Share** https://scratch.mit.edu/ Accessed: 2019-05-08.

4.5 Simulation and visualisation

The University of Colorado has curated the PhET collection of interactive simulations. Most of these can be run in a browser window, though some require a Java runtime environment [Flanagan, D. 2005. Java in a Nutshell. O'Reilly] to be installed. The simulations are indexed according to subject and grade level. There are teacher's guides for how to use the simulations for teaching, as well as workshops where teachers can practice using simulations. Using the simulations requires a clear learning objective to avoid that the pupils

only play around with the settings without carefully observing how the simulated process is affected by modifying its parameters.

The simulations are available in multiple interface languages, so pupils can choose their native language. The quality of the simulations is somewhat variable, with often fairly crude user interfaces.

Online Resources

PhET Interactive Simulations
https://phet.colorado.edu/
Accessed: 2019-05-09.

Download Free Java Software
https://java.com/en/download/
Accessed: 2020-06-15.

4.6   Location-based games

Mobile phones with GPS tracking allow the playing of games that are located in physical space [1]. These can then be designed to, e g, teach about the pupils' hometown, by requiring the pupils to move to historically interesting sites and receive information at the spot. They do however still require quite a bit of work in the classroom for the lesson to sink in [2, 3].

Resources

[1]   Ejsing-Duun, S. 2011. *Location-based games: from screen to street*. Aarhus University.

[2]   Benford, S., Rowland, D., Flintham, M., Hull, R., Reid, J., Morrison, J., Facer, K. and Clayton, B. 2004. "Savannah": Designing a location-based game simulating lion behaviour. *International conference on advances in computer entertainment technology* (2004).

[3]   Avouris, N. and Yiannoutsou, N. 2012. A review of mobile location-based games for learning across physical and virtual spaces. *Journal of Universal Computer Science*. 18, 15 (2012), 2120–2142.