ATS2020
Assessment of Transversal Skills

ATS2020 Technology and Tools

ATS2020 - Assessment of Transversal Skills 2020

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Co-funded by the
Erasmus+ Programme
of the European Union

Erasmus+ Programme 2014-2020
Key Action 3: Support for policy reform

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D1.4: ATS2020 Technology and Tools

Project Title:	Assessment of Transversal Skills 2020
Project Acronym:	ATS2020
Project Number	388446-EPP-I-2014-2-CY-EPPKA3-PI-POLICY
Grant Agreement Number	2014-3647/001-001
Deliverable number	D.1.4
Work Package	1
Work Package Leader	Cyprus Pedagogical Institute
Work Package Essential Partners	CTI, H2, ERI
Dissemination level	Public
Delivery date	24 June 2016 (final version)
Status	Submitted
Version	Final (English version)
Author(s)	Andri Avraamidou
Editor	Anastasia Economou
Deliverable Manager	Anastasia Economou
Site to download:	ats2020.eu/deliverables

Co-funded by the Erasmus+ Programme of the European Union

Disclaimer: This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

MODIFICATION CONTROL				
Version	Date	Status	Author	Modifications in short
V1.0	15/9/15	In progress	Adri Avraamidou	Structure and first input
V2.0	28/9/15	In progress	Adri Avraamidou	All chapters developed
V3.0	7/10/15	First version	Review and edit by Anastasia Economou	Review and edit
V4.0	24/6/16	Final	Final review and edit by Anastasia Economou	Final review and edit

ATS2020
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Technology and tools
for a formative assessment process

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October 2015

Nicosia, Cyprus

Co-funded by the
Erasmus+ Programme
of the European Union

Contents

1. Introduction

1.1. Purpose and aims of this deliverable

The purpose of this deliverable is to provide a theoretical and research background regarding the use of tools and technologies for supporting formative assessment processes in education, as part of the ATS 2020 project. Thus, this deliverable reviews a range of tools and technologies that are currently being used in classrooms formatively, as found in evidence-based research literature; rubrics, scripts, wikis, blogs, concept maps, ePortfolios, computer-based assessment and (online) testing, classroom response systems, technology-enhanced learning environments, educational data mining and learning analytics. It does not, however, aim in discussing the technical specifications of such tools and technologies (as this will be approached in WP2 deliverables). Rather, it aims in introducing them to the reader and discussing their pedagogical potentials and ways they are currently being used by teachers and researchers in traditional and virtual classrooms. The tools and technologies being reviewed in this deliverable are presented in two sections; supporting students' internal feedback and self-regulation and supporting (external) formative assessment and feedback. However, this categorization is not absolute as it was made in order to help writing this deliverable. It is acknowledged that some of these tools and technologies can be used for various purposes.

1.2. Key Definitions

The Key Definitions for this deliverable are briefly presented next.

Formative Assessment: An assessment is *"…formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited"* (Black & Wiliam, 2009, p.9)

Feedback: *"…any information that is provided to the performer of any action about that performance"* (Black & Wiliam, 1998a, p.53)

Tool: any mediation used by a subject (i.e. teacher or student) in order to accomplish an object (i.e. objective) during an activity (Leont'ev, 1978). This might include physical tools such as a document, a ruler, a pencil, a computer or mental tools such as language, gesture, signs (Leont'ev, 1978).

Technology: Technology can be considered as a tool and as a range of tools that are technological in nature, in the sense that they exist in the digital world or in the form of a device.

Technology-Enhanced Learning (TEL): TEL conceives of all those learning situations where "technology plays a significant supportive role" (Goodyear & Retalis, 2010, p.vii).

Technology-Enhanced Learning Environment (TELE): TELEs are technology-based environments that can support learning (skills and knowledge acquisition) that emerges during students' interaction with a teacher/facilitator, their peers, supporting - online - material and other technological resources that are composing the learning environment (Wang & Hannafin, 2005; Aleven, Stahl, Schworm, Fischer & Wallace, 2003; Carneiro, Lefrere, Steffens & Underwood, 2011).

1.3.Structure of this paper

This paper is structured as follows:

1. Introduction: This part provides an orientation of the deliverable's content

2. Formative assessment and feedback in education: This part provides a compact literature review regarding the main elements of theoretical models and frameworks related to the process of formative assessment and effective feedback and their value for education.

3. Tools and Technology for supporting learning in good formative assessment process and feedback: This part illustrates the main tools that are usually implemented in good formative assessment strategies/procedures and effective feedback in classrooms, as found in and supported by related research. This part also provides an overview of the way existing technologies are being used in order to support good formative assessment and feedback. It draws upon existing research evidence and recommendations found in literature.

4. Conclusions: This part summarises the main elements of the previous parts and makes recommendations regarding the design of effective digital learning environments to support good formative assessment strategies and effective feedback. This part provides a summary of the whole paper.

5. References: A list of references of the literature that was used in order to write this deliverable.

2. Formative assessment and feedback in education

Assessment has been and still is a challenging matter for education and appears in literature in two main functions: summative and formative (Chappuis, 2009). *Summative assessment* focuses more in providing evidence of students' performance in order to make judgments regarding their capabilities and competences and/or a program's effectiveness in comparison to external standards and/or the performance of other students or programs (Chappuis, 2009; Bell & Cowie, 2001). This can provide monitoring opportunities for teachers, parents, students and policy makers for students' progress in order to identify areas of further improvement at the end of the process of learning and has been integrated in teachers' practice for many years (Bell & Cowie, 2001; Crooks, 2002). However, it appears that during the 1970's traditional summative assessment methods that were exclusively measuring students' classroom performance on the basis of external standards and behaviouristic perspectives, were questioned by several researchers and educators, a couple of years after Scriven (1967) referred to the term *formative assessment*. It is not indented in this report to argue on the effectiveness of the two functions of assessment over the other. Rather, both summative and formative assessment are essential in respect to the purpose that they fulfill (Chappuis, 2009) and as Crooks (2002, p.1) clarifies*: "summative assessment is intended to summarise student attainment at a particular time, whereas formative assessment is intended to promote further improvement of student attainment"*.

Furthermore, Taras (2005, abstract), argues that *"formative assessment is in fact summative assessment plus feedback which is used by the learner"*. She goes a step ahead arguing that the dichotomy that is being observed in literature regarding the two functions of assessment is "self-destructive" (Taras, 2005, p. 276) causing confusion for teachers in respect to what they need to change in their teaching as she believes that: *"most SA[1] for formal assessment purposes requires feedback; therefore the only real requirement in order to integrate FA into practice is to engage the learners with using this feedback for learning in future work"* (Taras, 2005, p.475). Indeed, surveys conducted investigating teachers' understanding of formative assessment reveal that teachers do not always understand formative assessment and their new roles and responsibilities (Pedder et al., 2005). Thus, it is important for teachers (and practitioners) to be able to understand what formative assessment is and the way their own role as well as their students' role change when implementing formative assessment processes in their classroom.

2.1. Formative assessment and feedback definitions

There is not one accepted definition of formative assessment in literature (Dunn and Mulvenon, 2009). In one early definition of formative assessment (19 years ago), Tunstall and Gipps (1996, p. 389) link teaching and assessment but they do not include learning: *"Formative assessment is the process of appraising, judging or evaluating students' work or performance and using that to shape and improve their competence"*. This definition encompasses the recognition and evaluation of students' performance in order to make adjustments to the teaching so as to improve it and not simply provide a grade, yet it does not encapsulate the entire learning process within a classroom. Sadler (1998, p.77) defines formative assessment as *"assessment that is specifically intended to*

[1] In Taras (2005) quote - SA: Summative Assessment / FA: Formative Assessment

provide feedback on performance to improve and accelerate learning", making the connection of assessment and learning clearer. However, this definition does not link teaching with assessment and learning. A more holistic definition is offered by Black and Wiliam (2009, p.9) who revised a previous definition of their own and describe assessment and practice being *"…formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited".* Black and Wiliam's definition includes students as participants in the process of formative assessment, stressing the self-regulation skills that students need to hold in order to become autonomous learners (Sadler, 1989) throughout the formative assessment process. Furthermore, Kahl (2005, p.11) states that: *"A formative assessment is a tool that teachers use to measure student grasp of specific topics and skills they are teaching. It's a 'midstream' tool to identify specific student misconceptions and mistakes while the material is being taught"*. Nonetheless, most definitions regarding formative assessment include an important component; feedback.

Feedback and formative assessment are interlinked. In 1983, Ramaprasad (p.4) defined feedback as: *"Information about the gap between the actual level and reference level of a system parameter which is used to alter the gap in some way".* Similarly, Black and Wiliam (1998, p.53) define feedback as *"…any information that is provided to the performer of any action about that performance"*. Feedback might be in a written form of comments during grading assignments, in oral form during classroom discourse or even gestures and is an essential part of the learning process for both teacher and students (Sadler, 2010; Bell & Cowie, 2001). Feedback is not provided only by the teacher but rather, as Yorke (2003) suggests, feedback can also be given formally and informally, by peers and other sources, such as mentors or even parents. Yet, Sadler (1989) argues that information by itself is not considered feedback unless it is used in order to improve a student's performance in an attempt to close the 'gap' between where the student is and where the student is expected to be. This is achieved through the activities that form the process of using such information to improve learning (Irons, 2008). However, research has shown that providing only grades or scores indicating students' performance or providing a vague feedback can have a negative impact on students (Kluger & DeNisi, 1996) as well as providing feedback that is critical or controlling (Ashwell, 2000). Feedback alone does not guarantee a sufficient effect on the standards of students' work (Crisp, 2007). In order to be effective, feedback needs to be specific and targeted (Bangert-Drowns, Kullick & Morgan, 1991). Thus, feedback is an integral part of formative assessment that requires teachers to develop designing skills so as to be specifically effective in designing and providing learning opportunities for their students to self-monitor and self-regulate their learning (Dixon, 2011). As Topping, Smith, Swanson and Elliot (2000, p.150) stated, formative assessment is valuable when it *"yields rich and detailed qualitative feedback information about strengths and weaknesses, not merely a mark or a grade"*.

Reviewing the way formative assessment and feedback are defined in literature reveals the high level of connection between the two concepts. To sum up, formative assessment is the process of identifying students' 'gaps' and then making adjustments to the learning activities (either by

teachers or students themselves) so as to close that 'gap'. This is usually done through effective feedback. The value of formative assessment and feedback will be discussed next.

2.2. The value of formative assessment and feedback in education over the years

Black and Wiliam (1998a) reviewed more than 250 publications reporting on the use of formative assessment in classrooms up to 1996, demonstrating the embracement of formative assessment in classrooms at the time[2]. Their meta-analysis report concluded that feedback and formative assessment had a positive impact on students' learning and achievement, especially low achievers and it has been used by many scholars in order to support the effectiveness of formative assessment and feedback. In addition, research examining formative assessment potentials in the 90s implied that limiting assessment only to summative-oriented strategies has a negative impact on students' learning and students' achievement (Kluger & DeNisi, 1996; Black & William, 1998). More recent research argues that formative assessment and feedback are valuable for students as they can benefit students' progression (Bermingham & Hodgson, 2006), enhance students' motivation and self-esteem (Nicol & MacFarlane-Dick, 2004) and help students' be self-regulated learners (Black et al, 2003; Nicol, 2008) as it can provide valuable insights on their learning strategies (Yorke, 2003; Sadler, 1998). Formative assessment is also valuable for teachers, as it focuses on the process of learning and the evidence it produces is used to make adjustments during instruction in order to enhance and improve students' learning (Cowie & Bell, 1999; Shepard, 2008). Teachers can use this evidence in order to adapt their teaching, improve their teaching methods and adjust their learning design process accordingly (Wiliam, Lee, Harrison & Black, 2004). Furthermore, evidence elicited through formative assessment, when used in a summative way, can inform other stakeholders, such as parents, school and community regarding the progress of the subject that is being assessed (Smith, 2007).

After seeing what was 'Inside the Black Box' of formative assessment (Black & Wiliam, 1998b), Wiliam, Lee, Harrison and Black (2004), conducted a research in which they examined the mathematics and science achievements of secondary education students who were in classrooms that had and had not formative assessment interventions. They found that the treatment group of students had a mean effect size of .32 over the control group regarding their achievement. Furthermore, in their research, Wiliam and Thomson (2007) found that, in comparison to reducing the number of students in a classroom or increasing teachers' level of understanding of content knowledge, formative assessment has in fact a greater effect on students' achievement. In addition, Ruiz-Primo and Furtak (2004) explored the use of three informal formative assessment strategies – eliciting, recognizing and using information (that correspond to the formal strategies of gathering, interpreting and acting, respectively) by 3 middle school science teachers, arguing that the quality of teachers' use of those strategies was positively linked to students' achievements.

[2] Dunn and Mulvenon (2009) challenged the validity of Black and Wiliam (1998a) review, identifying methodological issues with almost all research papers that they used in order to reach those conclusions. In fact, Dunn and Mulvenon (2009, p.1) stated that: *"a review of the literature revealed limited empirical evidence demonstrating that the use of formative assessments in the classroom directly resulted in marked changes in educational outcomes"*.

The formative function of the assessment is perceived as an integral part of the everyday teaching and learning process in education (Juwah, McFarlane-Dick, Mathew, Nicol, Ross & Smith, 2004; Harlen & James, 1997) and is a contextualized part of learning in which teacher/student interaction is essential (Wyse & Torrance, 2009). In fact, socio-cultural theories of learning (Pryor & Crossouard, 2008; Black & William, 2006) and constructivist learning theories (Gipps, 1994) recognize the opportunity of a more holistic assessment method offered by formative assessment strategies.

Thus, a shift towards formative assessment process was observed (Black and William, 1998a). This shift affected and perhaps redefined the roles of teachers and students in the assessment process as the student was now actively involved in the process and was not left depended on the teacher's assessment (Torrance & Pryor, 1998) and this is evident when reviewing the way definitions of formative assessment evolved over the years. Feedback, through this new paradigm is no longer considered as just correcting students' work but rather, it is seen as facilitator, focusing on scaffolding students' learning within the student's zone of proximal development (Vygotsky, 1978). This resulted in several discussions in the research community that in turn resulted in the emergence of a new paradigm of assessment (Harlen & James, 1997) and the emergence of new frameworks and terminology regarding assessment, such as Assessment for Learning (Assessment Reform Group, 2002; Chappuis, 2009) and learning-oriented assessment (Knight, 2006; Carless, 2005).

A newer concept that is redefining and upgrading student's role in formative assessment process in literature is 'Assessment for learning' (Cowie, 2005). The Assessment Reform Group (2002, p.2-3) defines Assessment for Learning as: *"…the process of seeking and interpreting evidence for use by learners and their teachers to decide where the learners are in their learning, where they need to go and how best to get there".* Even though formative assessment and assessment for learning seem quite similar concepts, the difference is that assessment for learning captures the essence of assessment while learners are also responsible to use the information to improve their own learning, making the connection of learning and assessment explicit (Gardner, 2006; Cowie, 2005).

2.3.Formative assessment and effective feedback models and frameworks

As discussed earlier, Black and Wiliam's (1998a) report was very informative in terms of understanding formative assessment effectiveness through the review of research reports found in literature. Black and Wiliam (1998a) concluded in that report that students' gained more when they were involved in formative assessment processes and proposed that formative assessment is effective when it involves: i. teachers adapting their practice according to the evidence they receive from assessing their students formatively, ii. students receiving feedback and advice regarding their work and what they need to do to improve and iii. students being actively involved in the assessment process through self-assessment learning activities. Thus, it is important for both teachers and students to be involved in a formative assessment process.

Many researchers have used Sadler's (1983, 1989, 1998) work on formative assessment as it was one of the early theories being developed in the field that has managed to connect research evidence to teaching and learning practice. For Sadler (1989), teachers and their students need to work closely forming a partnership through effective feedback that helps sharing and clarifying what he calls the teacher's "guild knowledge" (p.127). For Sadler (1989), students' self-monitoring and self-regulation development is pivotal. He argues that in order for students to be more autonomous

and self-monitor their learning, they need to develop a similar level of understanding of evaluative concepts and skills as their teachers hold (Sadler, 1989; Yorke, 2003). He illustrated (Sadler, 1989) three conditions important for effective feedback:

1. *Communicating standards to students*

   Communicating the expected standards of their performance to students, enables them to get involve and understand the way they are being assessed, by possessing an understanding of the goal.

2. *Making multicriterion judgments*

   Students should be actively involved in the feedback process so as to be able to compare their performance to the appropriate standards and make judgments based on multiple criteria and not only on their teachers' information but also on information they produce themselves.

3. *Strategies for closing the gap*

   After students become aware of the expected standards and goals as shared and discussed with the teacher and make judgments based on multiple criteria on their level of performance, students should be *"able to select the appropriate strategies to bring their performance closer to the goal"* (Sadler, 1989, p.138).

Sadler's conditions of effective feedback and overall formative assessment framework informed and guided the work of other researchers (such as Juwah et al., 2004). For example, Wiliam and Thompson (2007) highlight five key strategies for good formative assessment, which they classify using elements of Sadler's conditions (Table 1)

<table>
<tr><th></th><th>Where the learner is going</th><th>Where the learner is right now</th><th>How to get there</th></tr>
<tr><td>Teacher</td><td rowspan="3">1. Clarifying and sharing learning intentions and criteria for success</td><td>2. Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding</td><td>3. Providing feedback that moves learners forward</td></tr>
<tr><td>Peer</td><td colspan="2">4. Activating students as instructional resources for one another</td></tr>
<tr><td>Learner</td><td colspan="2">5. Activating students as the owners of their own learning</td></tr>
<tr><td></td><td>Understanding and sharing learning intentions and criteria for success</td><td colspan="2"></td></tr>
<tr><td></td><td>Understanding learning intentions and criteria for success</td><td colspan="2"></td></tr>
</table>

TABLE 1: ASPECTS OF FORMATIVE ASSESSMENT (WILLIAM & THOMPSON, 2007)

The three phrases shown in William and Thompson (2007) table (Table 1) above, are often found in formative assessment guides for teachers in order to assist students become more autonomous in their learning, changing them into: *"Where am I now?", "Where do I want to go?" and "How to get there?"* (Hattie & Timperley, 2007). This highlights the 'gap closure' nature of formative assessment

(Sadler, 1998). The strategies illustrated above involve peers in the formative assessment process and refer to activating a student not only as the owner of his/her own learning but also as a responsible peer that provides feedback to his/her fellow students. Table 1 also indicates another important aspect in respect to feedback; A student does not get feedback externally only from his/her teacher but also from his/her peers and internally through his/her own self-regulating processes. Furthermore, Wiliam (2009) stresses that a formative assessment might be implemented in short, medium and long cycles; Short cycles can be implemented within and between lessons and can take minutes or hours, focusing mostly on classroom engagement and practice. Medium cycles can be implemented within and between teaching units that can take days or a few weeks, focusing mostly on improving student's learning and raise awareness of learning issues. Long cycles of formative assessment can be implemented across units or terms through weeks or even months and is focusing mostly on monitoring student's progress throughout the curriculum.

At the same time (2006-2007), in the USA, several researchers that formed the Formative Assessment for Students and Teachers State Collaborative (FAST SCASS) of the Council of Chief State Officers identified the following five attributes (Council of Chief State School Officers (CCSSO), 2008, p.4-5) that are crucial to formative assessment process, as found in literature:

"• **Learning Progressions.** Learning progressions should clearly articulate the sub-goals of the ultimate learning goal

• **Learning Goals and Criteria for Success**. Learning goals and criteria for success should be clearly identified and communicated to students

• **Evidence of Learning**. Evidence of learning is elicited during instruction

• **Descriptive Feedback.** Students should be provided with evidence-based feedback that is linked to the intended instructional outcomes and criteria for success

• **Self- and Peer-Assessment**. Both self and peer-assessment are important for providing students an opportunity to think meta-cognitively about their learning

• **Collaboration**. A classroom culture in which teachers and students are partners in learning should be established"

Heritage (2010) who was the advisor of FAST SCASS, developed a model (Figure 1) for formative assessment following those attributes in order to help teachers understand the way to implement formative assessment. Earlier, she identified four elements of formative assessment in her model stressing the importance of teachers' clear understanding of: *"1) identifying the "gap," 2) feedback, 3) student involvement, and 4) learning progressions"* (Heritage, 2007, p.141). The first three elements are similar to Wiliam and Thomson's (2007) model, however, Heritage's (2007) model adds another element that was also present in FAST SCASS attributes: *learning progressions*. Heritage (2007, p.142) stressed the limited capability of several state standards (in the USA) to offer teachers a: *"…clear progression for understanding where students are, relative to desired goals".* She argues that *"(T)he learning progression should clearly articulate the subgoals that constitute progress toward the ultimate goal".*

Describing briefly Heritage's (2010) model, in order for formative assessment to be effective, teachers need to identify the learning goals and sub-goals for learning progressions and set the

criteria for success. During teaching and within a feedback loop that involved the interaction between teachers and students and between students themselves, teachers need to elicit evidence of students' learning using the classroom's classroom (teacher assessment, students self- and peer-assessment), interpret the evidence so as to identify the gap and then adapt their teaching by setting instructional goals describing again the criteria for success and adapting their teaching so as to scaffold students closing the 'gap' within their zone of proximal development and what they can achieve. Heritage's model (2010), as well as the model of Wiliam and Thompson (2007), place teachers in a central place within the process of formative assessment. Yet, both teachers and students have a crucial role to play in such a process.

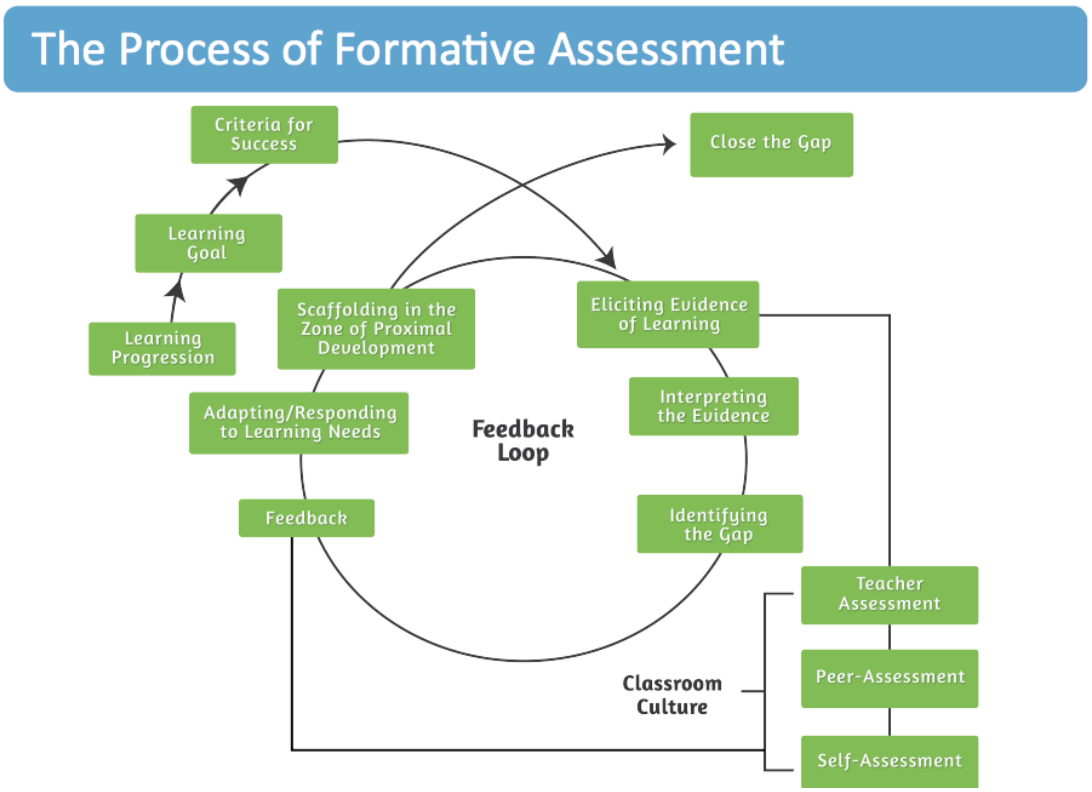

FIGURE 1: HERITAGE (2010) MODEL OF FORMATIVE ASSESSMENT

A conceptual model of formative assessment and feedback, that places student's role centrally, is the cycle model (Figure 2) of Juwah et al. (2004). Their model was developed through the Student Enhanced Learning through Effective Feedback (SENLEF) project that aimed in informing practitioners regarding Formative Assessment and Feedback practices in Higher Education. As an outcome of that project, Juwah et al. (2004) conducted a literature review of existing research and theories related to FA and feedback, developed a series of case studies in Higher Education, identified seven principles for good effective practice and conceptualized a theoretical model of formative assessment and feedback. As they explain in their paper (p. 4-5), their cycle model (Figure 1) drew on the work of Sadler (1983), Black and Wiliam (1998a), Yorke (2003) and Torrance and Pryor (1998) and starts with the teacher setting a task (goals and/or criteria). Then, the student tries to interpret the task through his/her previous domain and strategy knowledge and motivations. S/he then sets his/her own goals, tactics and strategies in order to generate learning outcomes. Through this time, these internal monitoring processes of the student generate internal feedback that the student uses in order to re-interpret internal goals, tactics, strategies and tasks. In addition,

if external feedback is provided by a teacher/peer/other, then the student interacts with additional information that might enhance, concur or conflict his/her interpretations and alter the learning outcomes.

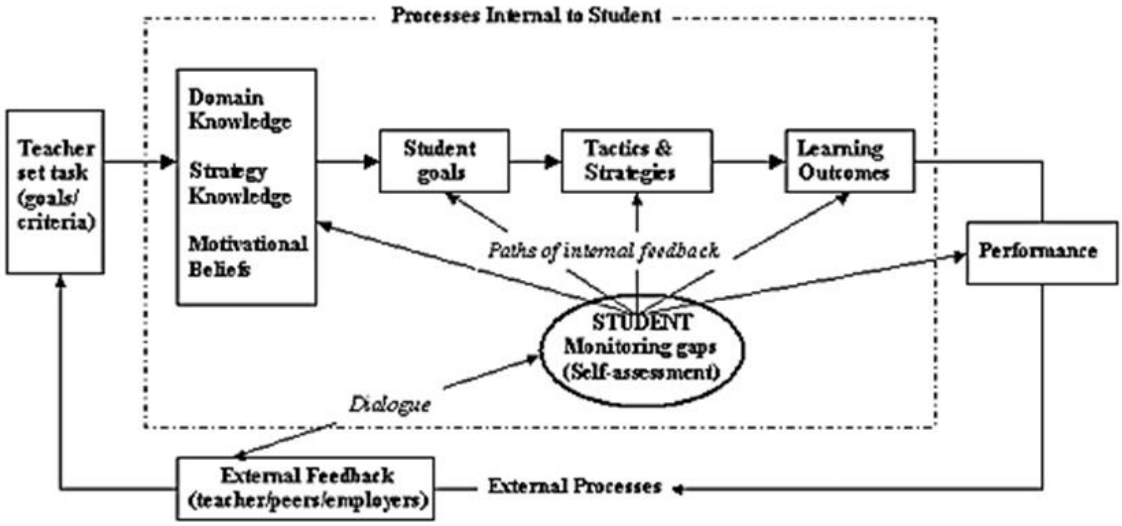

FIGURE 2: JUWAH ET AL. (2004) CONCEPTUAL MODEL OF FORMATIVE ASSESSMENT AND FEEDBACK

It is beyond the scope of this report to provide an extended analysis of the model, however this model is important because it highlights the processes that are internal to a student, including his/her own goals, strategies and tactics and prior understandings. From their work, Juwah et al. (2004, p.6) indicated seven principles of good feedback practice that can facilitate self-regulation:

1. Facilitates the development of self-assessment (reflection) in learning.
2. Encourages teacher and peer dialogue around learning.
3. Helps clarify what good performance is (goals, criteria, standards expected).
4. Provides opportunities to close the gap between current and desired performance.
5. Delivers high quality information to students about their learning.
6. Encourages positive motivational beliefs and self-esteem.
7. Provides information to teachers that can be used to help shape the teaching.

Sharing learning goals and criteria for success to students is important for enabling students' self-regulation during learning activities (Black & Wiliam, 1998a;1998b). This kind of activity was also illustrated by Juwah et al. (2004) as an activity that facilitates effective feedback. Research has argued that what teachers set as learning indentions (learning goals) often mismatch to what students perceive as their goals during a learning activity (Hounsell, 1997). Thus, students do not always understand their teacher's feedback as they do not share the same understanding regarding the learning goals and criteria for success. This is also supported by Havnes, Smith, Dysthe and Ludvigsen (2012) who argue that students perceive feedback practices differently than their teachers and as Nelson's (2007) research showed, students do not always access feedback and hints despite the fact that it was available for them in immersive learning environments. Juwah et al. (2004) principles are connected with the five strategies of Wiliam and Thomson (2007) as both refer to self-regulation, goal and assessment criteria sharing, gap closure, active discussion between teachers-students-peers and quality information for both students and teachers through effective feedback.

2.4.Formative Assessment and the role of Technology

Given the rapid development of technology and the use of technological tools (i.e. computers, interactive whiteboards, online platforms, mobile devices etc.) in education, the nature of formative assessment is affected as new technologies can reshape teaching and learning practices (Weller, 2011). McFarlane (2001) stated that in educational research ICT is seen as skills and competences, as a vehicle for teaching and learning or as an agent of change. In this report, ICT and Technology is seen as a vehicle for teaching and learning and as an agent of change. Either teaching in a physical classroom or a virtual one through e-learning platforms or teaching in a blended learning environment, technologies exist to assist teachers assessing their students by collecting evidence of their students' learning and also facilitate students' self-assessment, peer-assessment and self-regulation processes. Thus, several projects have been implemented in order to investigate the role of technology in fostering formative assessment; *CCMS Project: Classroom Connectivity in Promoting Mathematics and Science Achievement*; *FANC Project: Formative assessment in a networked classroom; ITEAM Project: Integrating Technology-Enhanced Assessment Methods; FASMED project: Improving Progress for Lower Achievers through Formative Assessment in Science and Mathematics Education*.

Inevitably, the existence of technologies and technological tools that could be used for formative assessment purposes and the gradually increasing focus of relevant research caused an emergence of modernized terms of formative assessment that integrate technology. For example, Pachler, Daly, Mor & Mellar (2010, p.716) referred to *'formative e-assessment'* as: *"the use of ICT to support the iterative process of gathering and analyzing information about student learning by teachers as well as learners and of evaluating it in relation to prior achievement and attainment of intended, as well as unintended learning outcomes*" (p. 716). In other words, formative e-assessment definition includes elements of formative assessment definitions but it specifies that the kind of tool that supports formative assessment is ICT in nature. Thus, teachers need to merge technology with their existing teaching practices (DeBarger, Penuel, Harris & Schank, 2010). Yet, the merge of technology and pedagogy in formative assessment teaching practice is not that easy and studies have shown that teachers think it is problematic (Penuel et al., 2007; Beatty & Gerace, 2009). For this reason, Beatty and Gerace (2009) developed a pedagogy for using Classroom Response Systems[3] (CRS) in science classrooms, named Technology-Enhanced Formative Assessment (TEFA). According to Beatty and Gerace (2009, p.146): *"In TEFA, four principles enjoin the practice of question-driven instruction, dialogical discourse, formative assessment, and meta-level communication*". Teachers, with the use of CRS devices, need to enable students' focus on the subject through a cycle of posing inquiry-based challenging questions so as to enable students developing their understanding through dialogical discourse and at the same time, collect evidence of students' learning and adapt their teaching through formative assessment strategies. Lastly, teachers help their students developing meta-cognitive skills through discussions of meta-level communication to close the cycle (Beatty & Gerace, 2009).

[3] See section 3.3.2

2.5. Summary

As it can be seen by the above frameworks and principles, formative assessment is progressively seen as a tool for enhancing and informing learning, rather than assessing it (Black, Harrison, Lee, Marshall, & Wiliam, 2004) and as Yorke's (2005) research on formal and informal formative assessment suggests, a student can get feedback from teachers, peers, others (i.e. mentor, supervisor) and from self (see Yorke, 2005, p.225). Reviewing the above principles and models it seems that to ensure good formative assessment, teachers need to share learning goals with students, enable students to self-monitor and self-regulate their own learning, provide high quality and not just informative feedback to students after making multicriterion judgments and help their students close the 'gap' involving them in the process of assessment. At the same time, students need to become self-regulated learners, take control of what they are learning, set and share goals with teachers and peers, evaluate their own work and the work of their peers and be able to understand feedback they receive either internally or externally (Nicol & Milligan, 2006).

Thus, it is evident that there is a change to the roles that teachers and students need to play in good formative assessment process. Teachers are no longer seen as being in control of the process with students being depended by what their teachers say (Clark, 2011). Rather, students' role has been upgraded to a more actively involved agent in the process both as an individual self-regulated learner and as a critical peer. This, of course, was something that was foretold, as the cumulative emphasis given on socio-cultural learning theories and theories of metacognitive and self-regulated learning that have been gaining ground in educational research, argued that students' role in their assessment process should be central (Bell & Cowie, 1997; Sadler, 1998; Torrance & Pryor, 1998).

3. Technology and Tools (T&T) for a formative assessment process

Throughout the years, a wide range of tools and techniques were recommended and were used by teachers in the classroom in order to enhance learning activities and establish good formative assessment and effective feedback. In this report, Tools are considered in the sense of Activity Theory; as any mediation used by a subject (i.e. teacher or student) in order to accomplish an object (i.e. objective) during an activity (Leont'ev, 1978). This might include physical tools such as a document, a ruler, a pencil, a computer or mental tools such as language, gesture, signs (Leont'ev, 1978). In this report, Technology can be considered as a tool and as a range of tools that are technological in nature, in the sense that they exist in the digital world or in the form of a device.

A range of technologies and technological tools exist that can facilitate important components of effective formative assessment, such as students' self-assessment and self-regulation, peer-assessment and teachers' elicitation of evidence of students' understandings. Heritage (2007, p.144) argues that "*(t)eachers' skills in drawing inferences from students' responses are crucial to the effectiveness of formative assessment*". Indeed, as it was emphasized in Part 2 of this report, the ability to elicit evidence of student's understanding is an important element of adapting teaching according to students' needs. Without a technological tool, teachers can elicit such evidence and provide feedback to students mainly through effective questioning and classroom discourse, observation of students' classroom work and behaviour and with students keeping a record of their learning (Garrison & Ehringhaus, 2007). However, Hattie and Timperley (2007) argue that the most effective feedback forms in relation to the learning goals are computer-assisted, video and audio instructional feedback. Indeed, several technology-enhanced learning environments (i.e. online platforms) can facilitate the use of such multimodal feedback.

Part 3 is divided in two sections. First, it will provide a brief discussion of literature related to specific tools (and technological tools) that are frequently used by teachers to enhance students' self-regulation and self-assessment skills; Rubrics, Scripts, Blogs, Concept Maps and ePortfolios[4]. Second, it will discuss a range of technologies that have been highly associated with effective formative assessment and feedback in the literature; Computer-Aided Assessments; Classroom Response Systems; Technology-Enhanced Learning Environments and Educational Data Mining and Learning Analytics.

3.1. T&T for supporting students' internal feedback and self-regulation

Students' internal feedback, as shown earlier in Juwah et al. (2004) model, places self-regulation as a very important skill that a student needs to hold. There are several approaches that have been connected to self-regulation, such as *self-assessment*, a process that facilitates self-regulation and self-monitoring (Peters & Kitsantas, 2010; Puustinen & Pulkkinen, 2001) and *peer-assessment*, a process that requires students to develop skills and understand assessment criteria so as to assess their peers, providing and – if they are the ones who are being assessed by their peers – receiving feedback (Nicol & Milligan, 2006). In fact, it is argued that the skills that students need to develop during peer-assessment can be transferred when they come to regulate their own learning of the

[4] ePortfolios can be used to enhance students' self-regulation and at the same time, they can be used for formative assessment and feedback. However, thy will be discussed in the first section of Part 3.

matter (Gibbs, 1996). In addition, Kostons, van Gog and Paas (2012) argue that self-assessment and task-selection skills play a crucial role in students' self-regulation, as they researched students observing human models of performing self-assessment and engaging in task-selection processes. Furthermore, Efklides (2011) argues that the type and degree of self-assessment depend on the goals that the student is trying to achieve – that might be set by the students themselves or by the teacher's instructions – and also by the student's perceived effectiveness that can be improved through teacher's effective feedback.

Teachers are using several tools in order to support a self-assessment process, yet three are the most commonly used in a classroom; *self-grading/self-evaluating, rubrics* and *scripts* (Alonso-Tapia & Panadero, 2010). *Self-evaluation* is the kind of activity that students go through so as to mark their own work – usually – with a numeric score. Even though this activity does require students to be able to evaluate themselves, research has shown that it is not as effective, as it does not provide quality information to students so as to improve their learning, apart from a number of score (Docky, Segers & Sluijsmans, 1999). *Rubrics* and *scripts* on the other hand, provide a more dense and usable information to students so as to assess their work (and their peer's work) while being informed of the assessment criteria (Alonso-Tapia & Panadero, 2010). Rubrics and scripts can be used to support peer-assessment activities as well. Thus, tools that involve making assessment criteria visible seem to be more effective for promoting self-regulation skills.

Furthermore, due to the rapid application of technology in education, apart from *rubrics* and *scripts*, teachers have been using technology-supported tools such as: *simulations* that allow students to receive immediate and accurate feedback (Barzel, Drijvers, Maschietto & Trouche, 2005) especially in science and mathematics where students can test hypotheses through experimentation with the software and reflect on the effect of their actions when changing different parameters (Apostolopoulou, Panagiotakopoulos & Karatrantou, 2014), *journal keeping* (or online blogs for sharing with peers and others) so as to make their internal processes explicit, portfolios and *ePortfolios* so as to regulate their own work, achievements and learning. The way those tools are employed by teachers so as to enable students as owners and self-regulators of their own learning and also help students act as resources for one another is discussed in more detail next.

3.1.1. Formative use of Rubrics

Rubrics are tools for communicating assessment criteria of an assignment or a set of assignments, by describing the levels of quality of work needed in order to satisfy each criterion (Reddy & Andrade, 2010; Panadero & Johnson, 2013). Rubrics are employed in order to assess multi-dimensional and complex performances in a more reliable manner (Andrade & Valtcheva 2009; Jonsson & Svingby, 2007). Rubrics might be teacher-centered in the sense that they can be developed and used by teachers in order to help them assess a student's piece of work or be student-centered in the sense that they can be developed by either teacher or students and be used (or shared to) by students in order to assess their own or their peer's piece of work (Jonsson, 2008). Given the principles for good feedback and formative assessment practice discussed earlier, it seems that rubrics, when used formatively and in a student-centered way, allow teachers to share learning criteria in a multimodal manner, helping students (and teacher) to understand the expected levels of performance and collect information and evidence on where their performance is in respect to

the shared multicriteria (Vonderwell, Liang & Alderman, 2007). In addition, it has been argued that making scoring of students' work more analytical increases reliability of the assessment (Gaytan & McEwen, 2007).

However, recent meta-analyses of research investigating the formative use of rubrics in the classroom shows mixed results regarding their effectiveness for students' learning (Panadero & Jonsson, 2013; Jonsson & Svingby, 2007). A number of studies suggest that students' performance is improved when they are involved in the use and development of rubrics (i.e. Andrade, 1999; Andrade & Du, 2007; McCormick, Dooley, Lindner & Cumins, 2007), whereas other studies argue that there is no significant differences in students' work quality with or without the use of rubrics (Reitmeir & Verchota, 2009).

More specifically, as reported by Brown, Glasswell and Harland (2004) research, the treatment group that used rubrics in order to self-assess their writing outperformed the control group, significantly, with an effect size up to 1.6. This was also reported in a research conducted by Andrade (1999) in a science class in which the students who used a rubric to self-asses their work outperformed the control group (effect size = 0.99). The above results are indicators that when rubrics are used as a tool during formative self-assessment purposes, can facilitate improvement in students' performance. Similarly, research investigating the use of rubrics formatively in peer-assessment and self-assessment in writing class has shown a 17% improvement in the treatment group's performance over the control group (Mullen, 2003). More recently, Balan (2012) reported a considerable improvement of treatment group's performance (effect size=1.43) in mathematics problem-solving activities that involved peer-assessment and rubrics use over the control group. In addition, Vonderwell, Liang and Alderman (2007) argue that the use of rubrics help students develop their decision-making skills as they become more actively involved in their assessment. The above research results imply that the use of rubrics could be beneficial for students' performance improvement. Nonetheless, rubrics were used formatively, in a student-centered way and involved activities of self-assessment and peer-assessment and not just the use of rubrics. This echoes Panadero and Jonsson (2013) argument that the composite results in research related to the formative use of rubrics might be because research evidence is not clear on the way rubrics actually improve students' performance or the factors that are significant in causing potential effect on students' performance.

In their recent meta-analysis Panadero and Jonsson (2013), after reviewing 21 research studies investigating formative uses of rubrics in classrooms, suggested that the use of rubrics "*may mediate improved performance through (a) providing transparency to the assessment, which in turn may (b) reduce student anxiety. The use of rubrics may also (c) aid the feedback process, (d) improve student self-efficacy, and (e) support student self-regulation; all of which may indirectly facilitate improved student performance"* (p.140). These ways seem to align with the principles of good formative assessment and feedback that were discussed earlier.

An example of a rubric (Figure 3) regarding the creation of a conceptual map is reproduced from Panadero & Alonso-Tapia (p. 568) below:

Score / Assessment criteria	4	3	2	1
Concepts	All the important and secondary concepts are included	Contains the important and some secondary concepts but not all	The important concepts are included but not the secondary ones	Some key concepts are lacking
Hierarchy	The organization is complete and correct and the map transmit it	The organization is correct but incomplete: some levels or elements are lacking	The organization is complete but incorrect: there are concepts in the wrong places	The organization is incomplete and incorrect
Relationships among concepts in different hierarchical levels	RELATIONSHIPS They are correct making connections among the correct concepts LINKS Explicit and help to better understand the relationships among concepts	RELATIONSHIPS They are correct but incomplete: some connections are lacking LINKS Incomplete: Only some are explicit but they are correct	RELATIONSHIPS Some are incorrect making connections among concepts that do not have any relationship LINKS Only some are explicit but some are incorrect	RELATIONSHIPS The majority are incorrect or there are only a few LINKS Incomplete and incorrect
Relationships among concepts from different columns	There are several connections making relevant relationships	There is only one	None	None
Simplicity and easiness of understanding	Its design is simple and easily understandable. There are examples.	Some relationships are difficult to understand. Contains a few examples.	There is an excessive number of connections There are no examples.	Neither the relationships nor the hierarchy are understandable. There are no examples.

FIGURE 3: RUBRIC TO SELF-ASSESS A CONCEPTUAL MAP DESIGN (REPRODUCED BY PANADERO & ALONSO-TAPIA (2013, P.568)

A common use of teacher's practice that aims in helping students identify criteria for success is the review of exemplars of good and poor work related to the learning activity their students are involved in (Nicol & Milligan, 2006; Handley & Wiliams, 2011). A rubric can provide a quality objective tool for assessing such exemplars and promote discussion within the classroom, as a point of reference. Lastly, apart from paper-based rubrics, there are several web-based rubric generators such as iRubrics that can help teachers and students develop, save and share rubrics.

3.1.2. Self-assessment Scripts

Scripts are usually structured as a set of questions that guide students regarding the 'expert' process steps that are necessary in order to accomplish a task and are designed in order to help students analyze the process or the final product (Panadero, Alonso-Tapia & Huertas, 2012). However, when scripts are being used in order to analyze their final products/outcomes students are found to focus mostly on the way they have performed rather than focusing on and monitoring the entire learning process by identifying their mistakes through the process for example (Bannert, 2009; Thillmann, Kunsting, Wirth, & Leutner, 2009). Similar to scripts are also prompts, cues and checklists that are quite often used by teachers (Panadero, Alonso-Tapia & Huertas, 2012). However, scripts are denser in the sense that the sequence of the questions-statements describes the order of steps by which the process of the task is being developed, demonstrating the way they are connected.

An example of a self-assessment script (Figure 4) for conceptual maps is reproduced below from Panadero & Alonso-Tapia (2013, p. 569):

1. Is it clear what should be included in the conceptual map?
2. Based on the previous questions, have I identified sufficient concepts to collect all the ideas from the original text?
3. Have I ordered the concept using a hierarchy having the most global ones at the beginning of the list?
4. Have I reviewed the list to add more concepts if needed?
5. Have I started to design the map with the most global concepts in the upper part?
6. Have I entered 3 or 4 sub-concepts under the most global ones? (Keep in mind that if you have more than 6 concepts under the same hierarchal level it might be possible to enter a new hierarchal level (though this is not always possible as, for example, there 8 insect types).
7. Have I linked the concepts using nexus –words that add information to the links for the relationship with more importance-?
8. Have I used links making relationship among different columns of the hierarchy?
9. Have I put some examples under the concepts so that they were easier to visualize?
10. Have I reviewed the conceptual maps once finished keeping in mind…
    …that there are different ways to organize the concepts?
    …what was the purpose and the information I had?

FIGURE 4: EXAMPLE OF SELF-ASSESSMENT SCRIPT FOR THE DESIGN OF A CONCEPTUAL MAP (REPRODUCED FROM PANADERO & TAPIAS (2013, P.569)

Like rubrics, scripts can be teacher-centered or student-centered in respect to the way they are being used. Scripts are, however, more efficient when used formatively and by students during a learning activity (Panadero & Alonso-Tapia, 2013). In a recent research of the use of rubrics and scripts by 120 third- and fourth- year secondary education students, Panadero, Alonso-Tapia & Huertas (2012) argue that the use of both tools resulted in a higher level of self-regulation in comparison to a control group with no assessment tools. In addition, they found that scripts had a greater effect on students' self-regulation than rubrics suggesting that *"…in the long run, it is better to focus students' attention on process – as scripts do – than on performance"* (p.812).

3.1.3. Blogs as reflective journals and peer-assessment tools

Blogs or Weblogs are Web2.0 tools that can be used either for professional journalism (Kelly, 2009) or for the purposes of sharing personal thoughts, moments, events and reflections of the owner of the blog (Chesney & Su, 2010). Blogs started being an interest for educational research since the late 90s (Sidek & Yunus, 2012). They are composed of chronologically uploaded posts, by a unique user, on a unique site that s/he can access after logging in. Blogs have been used in education in order to facilitate computer-mediated-communication and collaboration (Halic, Lee, Paulus & Spence, 2010), since teachers and students are able to commend their peers' blogs and respond to their peers comments regarding their own blogs (Deng & Yuen, 2011). In addition, blogs allow students to exchange ideas, provide feedback and share their thoughts and learning and teachers to share material related to their instruction as well as assessment criteria (Meinecke, Smith, & Lehmann-Willenbrock, 2013). Olofsson, Lindberg and Hauge (2011) analyzed the use of blogs as formative assessment practice in an online higher education course. They found that the design and use an individual journal blog during the course resulted in nurturing the 23 students' reflective peer-to-peer learning. Similarly, Cheng and Chau (2011) found that blogs have a positive impact on

peer-to-peer learning because of their capabilities to be accessed and used globally, by peers who might have different point of views. Furthermore, in another research of Swedish higher education students, Olofsson, Lindberg and Stödberg (2011) asked students to write blog posts and share videos of their work and performance through VoiceThread tool. The results of their analysis showed that the activity of blogging and commenting on their own and their peers' work and performance as they were shared online using a video facilitated reflection and communication among peers.

Yinger and Clark (1981) argue that writing a journal requires writers to be able to reflect on what they know, what they do, how they do it and what they feel about it. Similarly, when blogs are being used as journals, especially for educational purposes, the writers (students) can reflect (Boud, 2001), become responsible for their own blog space and the content of their writing (Wang & Woo, 2008) as they can *"provide students with a high level of autonomy while simultaneously providing opportunity for greater interaction with peers*" (Williams & Jacobs, 2004, p. 145). Deng and Yuen (2011) researched student teachers' use of blogs during their studies in higher education and developed a framework capturing educational affordances of blogs. The results of their research indicated that apart from writing a blog and commenting on other blogs, another important activity was present; reading. Figure 5 shows their framework and their conceptualization of three types of blogging behaviour; writing, reading and commenting. Through those behaviours, Deng and Yuen (2011) claim that six areas of educational affordances can be facilitated; self-expression and self-reflection through the writing process, social connection and reflection triggered by reading through the reading blogs process and social interaction and reflective dialogue through the commenting process. Apart from collaboration and peer interaction, blogs allow for documentation of the user's post entries, providing a record of the users' uploads and thus, in terms of education, keeping track of students' learning journal entries (Meinecke, Smith, & Lehmann-Willenbrock, 2013).

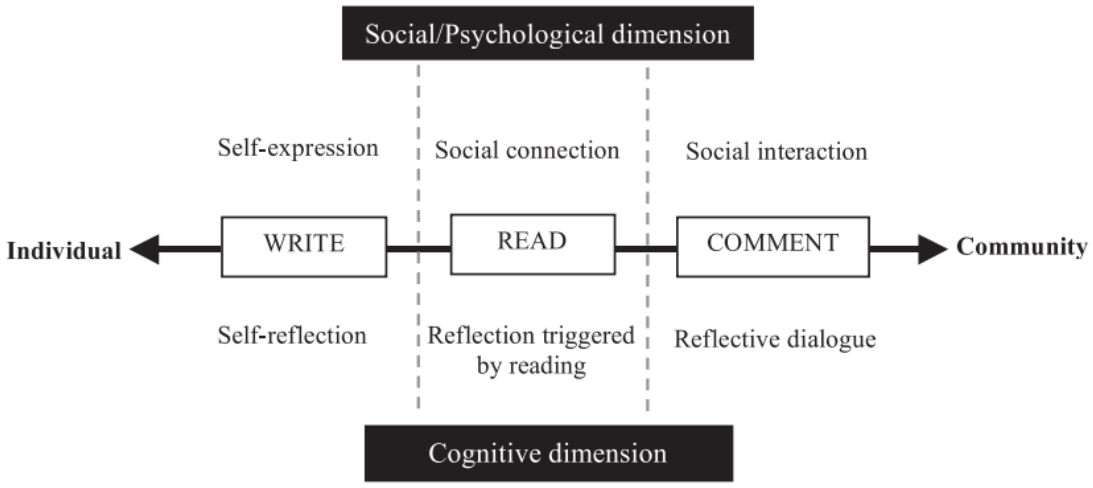

FIGURE 5: DENG & YUEN'S (2011, P. 450) FRAMEWORK FOR EDUCATIONAL AFFORDANCES OF BLOGS

It is observed that the bloggers' awareness that their blogs are being read by an audience makes the writing more social-oriented and emotional (Deng & Yuen, 2011; Nardi, Schiano & Gumbrecht, 2004). Yet, studies have found that students might not feel comfortable in sharing personal thoughts and feelings when they know that other people (peers, teachers etc.) can read and assess them (Robertson, 2011). This might cause teachers' difficulties in implementing blogging as an activity for

their students because of the students' lack of engagement (Kerawalla, Minocha, Kirkup & Conole, 2009). Examples of blogging websites that allow the creation of free blogs by users are: Blogger, Wordpress and Weeble. However, blogs and journals can be developed using the integrated journal/blog tools within a Virtual Learning Environment[5] (VLE) that can be more controlling in terms of limitation of the audience that can have access to the blog.

3.1.4. Wikis as tools that enable collaboration and peer-assessment

Wikis are Web2.0 tools that enable users to asynchronously contribute to the creation of a common wiki (web)page (with a single URL), regarding a specific topic of interest, by quickly editing text, pictures, videos, hyperlinks and other multimedia without necessarily knowing programming codes (Heafner & Friedman, 2008, Ng, 2014; Mak & Coniam, 2008). In fact, the *"ultimate typical feature"* of wikis is the editing part (Ebersbach, Glaser, & Heigl, 2006, p. 19). Wikis can exist in a stand-alone format, such as the quite popular Wikipedia, in which registered users can contribute to the development of the online encyclopedia. However, even though Wikipedia might be considered as a massive online contributing community, for educators, such collaborative activities need to be more constrained (Ng, 2014). For education, wikis are typically being used as collaborative tools that allow students to work together in order, for example, to illustrate their learning understandings of a topic (Elgort, Smith, & Toland, 2008).

Users can also create their own Wikis through the use of specialized wiki platforms, such as Wikispaces. Wikispaces also offer a platform that can be specifically used for education[6] providing the opportunity for teachers to create a Wikispaces' classroom in which teacher and students can contribute to the creation of common webpages for topics under study. In addition, teachers can monitor the progress of a wiki creation, by tracking contributors, content, time and number of revisions (Ng & Lai, 2012; Parker & Chao, 2007). However, platforms such as Wikispaces have some limitations in respect to the number of users that can be allowed in the teachers' Wikispaces classroom, limiting the 'tracking' and 'user monitoring' to what is freely offered.

Being able to track down in several timestamps and all intermediate stages of the wiki pertained, the process of authoring of a collaborative wiki is a very important function that helps teachers (as creators of a wiki) to track and monitor their students' individual contributions to a common collaborative activity and elicit evidence of their students' activities during the process, giving them the opportunity to assess the process and not just the end-product (Mak & Coniam, 2008). Research supports that the revision of a wiki, especially after receiving feedback and comments by the teacher and/or peers, can lead to self-assessment processes as for example, the development of authors' reflective thinking that prompts them to revise their contribution (Ng & Lai, 2012). Especially for language teaching and learning, wikis can be fruitful (Richardson, 2006).

Mak and Coniam (2008) illustrate an example of 24 secondary education students' authentic activity as they collaboratively created a brochure about their school, using a wiki. Students were divided in smaller groups and each group was responsible for writing a section of the brochure. The results of

[5] See section 3.2.3
[6] https://www.wikispaces.com/content/classroom

this research indicated that teachers could collect both qualitative and quantitative data of their students' contributions, by the tool and that by the end of the writing *"there was a considerable amount of expanding, reorganising and correcting taking place – supporting the notion that coherence improved" (*Mak & Coniam, 2008, p.452). Below, there is an example of the wiki writing process (Figure 6) as seen by Jane, one of the students that participated in Mak and Coniam (2008) study, as captured by the researchers (p.442). In this example, the wiki that was used was WikiHub by PBworks (http://www.pbworks.com/wikis.html).

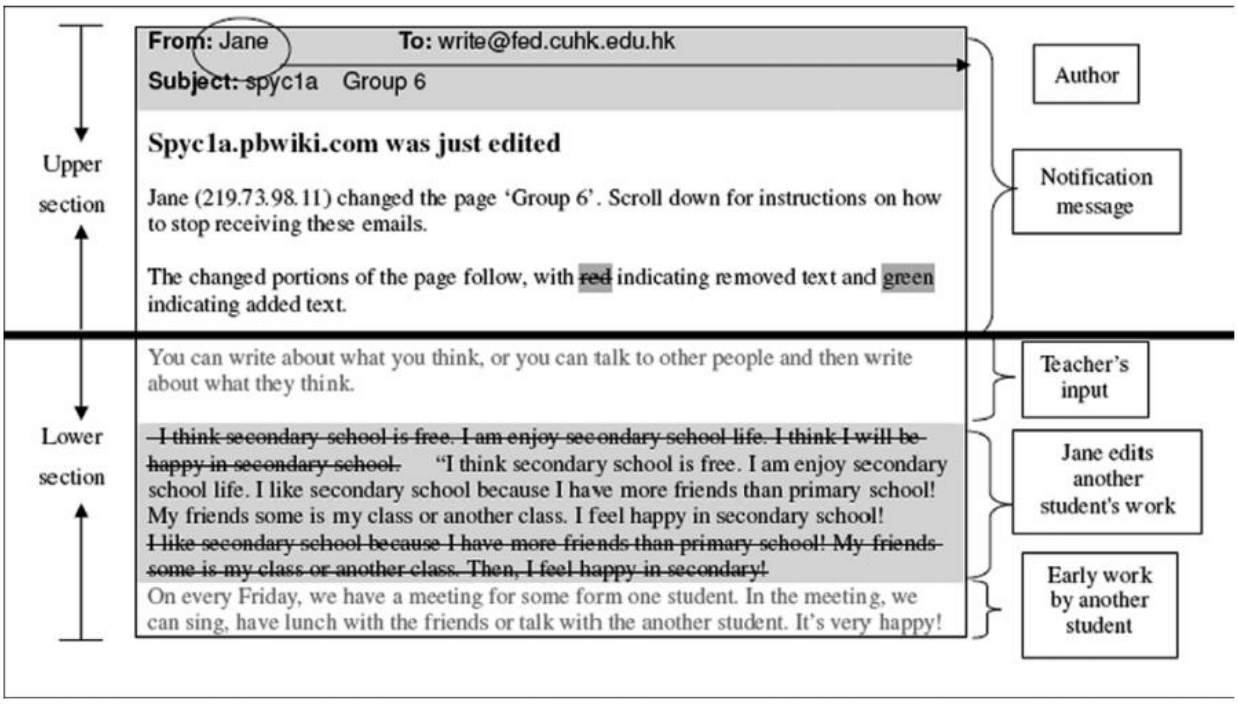

FIGURE 6: MAK & CONIAM (2008, P.442) SCREENSHOT OF STUDENTS COLLABORATING IN AUTHORING A WIKI

3.1.5. Individual, shared and interactive Concept Maps

Concept maps where first developed in 1970s, following cognitive theories, in order to make children's thoughts explicit (Novak & Cañas, 2006). Since then, this tool evolved in order to help students organizing effectively and meaningfully their thoughts and ideas of a concept (Peng, Su, Chu & Tsai, 2009; Novak & Gowin, 1984; Liu, Don & Tsai, 2005). Novak and Cañas (2006, p.177) refer to concept maps as tools that *"show the specific label (usually a word or two) for one concept in a node or box, with lines showing linking words that create a meaningful statement or proposition"*. The concepts on a concept map can be arranged hierarchically from the more general to the more specific using links (arrows) that connect the concepts and the propositions with one another, showing the relationship between them. Concept map tools affordance to illustrate visually individuals' cognitive structures was something that had positive effects on students' reflective thinking and self-awareness (Kao, Lin & Sun, 2008). Buldu and Buldu (2010), for example, researched the perceptions of 166 student teachers in a college who used concept maps during their training, regarding the tool's usefulness. Student teachers claimed that the tool was informative and useful in respect to their learning process awareness. Concept map software tools that allow someone connecting and analyzing concepts using text, audio and pictures is, for example, *Inspiration*, *Cmap*, *Smart Ideas*, *MindMeister*, *Compendium* and others.

Nevertheless, taking advantage of the World Wide Web (WWW), Concept Map tools evolved in a way that they not only visually represent one's reflective knowledge about a concept, but also becomes a mechanism for mining information and resources found in the internet, enabling students to go beyond stating what they know but organize and represent what they have searched and found (Lee, 2004; Cañas, Carvalho, Arguedas et al., 2004). An example given by Novak and Cañas (2006, p. 181) is presented below in Figure 7.

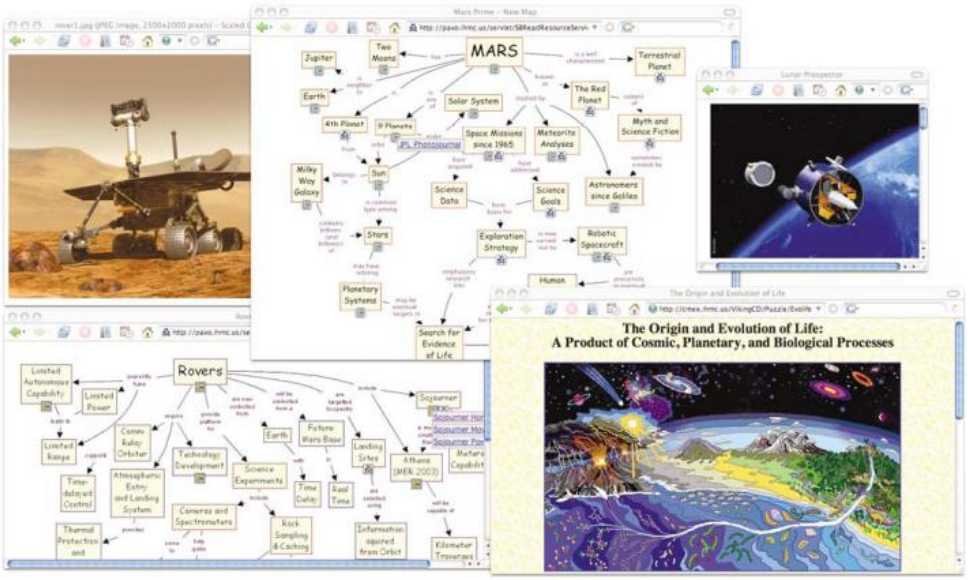

FIGURE 7 – NASA'S CONCEPT MAP REGARDING WHAT THEY HAVE FOUND IN MARS (NOVAK & CANAS, 2006, P. 181)

Figure 7 above, shows the way Nasa shared what they have found in Mars, using the upgraded version of Cmap tool that allowed attachments and connections of items distributed in the WWW.

Concept Maps are typically being used as instructional tools to help students organize their learning and research have shown that they can be used as a tool for summative assessment (Walker & King, 2003; Williams, 2004) and as something that could help teacher elicit evidence of students' learning (Novak & Cañas, 2006). However, there is limited research investigating the potentials of such dynamic concept maps in formative assessment (Buldu & Buldu, 2010). More recently, online Concept Map tools were developed following socio-cultural theories of learning, enabling users to collaboratively create concept maps, such as *Popplet*. Such tools allow users to work on a shared online concept map, by adding nodes, links and embed videos either synchronously or asynchronously, making the concept map multimodal. Most of those online tools provide opportunities for 'replaying' the sequence of actions of the users so that the students themselves and the teacher can go back and review the way the map was created. This kind of feature enables students and teachers to obtain a rich understanding and collection of evidence in respect to the process of creating a concept map and not just the final product.

Moreover and taking advantage of the use of mobile devices such as smartphones, tablets and Personal Digital Assistants (PDA), Hwang, Wu and Ke (2011, p.2273) adopted Cmap tool and developed a *"concept map-oriented Mindtool with a remediation mechanism, ICM 3 (Interactive Concept Map-oriented Mindtool for Mlearning)"* that allows students who have previously developed a concept map on a computer, to use their mobile devices so as to further develop and

revise their existing concept map *while* they are making observations on the field. Figure 8 below, shows the way this tool works during students' field observations on a natural science lesson, as explained by the authors (ibid, p.2273); on their mobile devices students can revise their concept maps by adding or deleting nodes and the ICM$_3$ mechanism compares the students' concept maps with the teacher's submitted objective concept map. The system them provides feedback to the students through the mobile device during field observations, with hints and supplementary material to help students develop their concept maps.

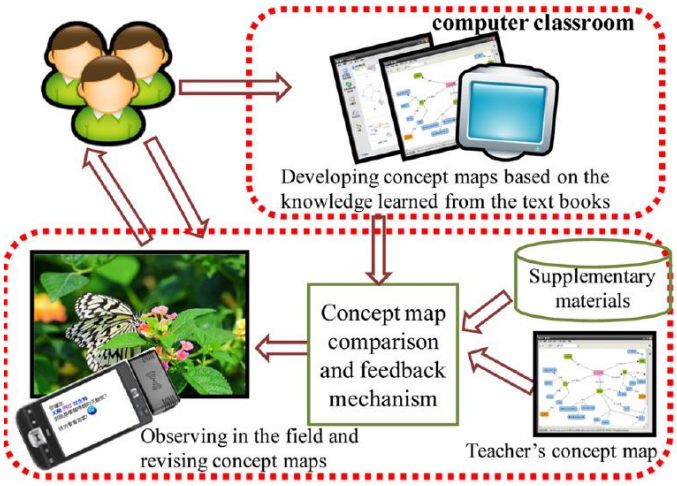

FIGURE 8: *INTERACTIVE CONCEPT MAP-ORIENTED MINDTOOL FOR MLEARNING (*HWANG, WU AND KE (2011, P.2273)

Hwang, Wu and Ke's (2011) research showed that the use of such a mechanism, even though the screen of the mobile devices was small, enhanced experimental group students' learning attitudes and at the same time improved their learning achievements in comparison to the control group, as students received feedback with hints and guidance immediately and formatively self-assessed their work.

3.1.6. ePortfolios

ePortfolios are often seen as a continuum of traditional Portfolios. Traditional, paper-based Portfolios have been used in education since the 1960s, mostly as a reflective collection of students' achievements and work (Ehley, 2006). However, it has been argued that such paper-based Portfolios were mostly used for summative assessment purposes and as a complementary way of assessing students' work (Yancey, 2009; Chatham-Carpenter et al., 2009). Yet, there were researchers, such as Stiggins (1994, p.87) who supported that Portfolio is *"not a form of assessment" as it is "a means of communicating about student growth and development".* With the advancements of technology, during the mid-1990s, educational Portfolios received a new form, a digital/electronic one that allows many possibilities for learning and teaching. ePortfolios (sometimes named Electronic Portfolios or Digital Portfolios) are found in literature in various ways and can be considered both as a product and as a process (JISC, 2007; Chang & Barker, 2006). Some argue that an ePortfolio is in fact a set of tools: *"an online environment loaded with electronic tools that can be used to develop and present a portfolio package"*, suggesting the invention of a *"new software management system"* (Jafari, 2004, p.40). Whichever the view of ePortfolio is embraced, it is highlighted by several researchers that ePortfolio's functions and shape are highly depended on its purpose and use

(Abrami & Barret, 2005; Fitch, Peet, Glover Reed & Tolman, 2008). For example, a Portfolio/ePortfolio developed for job seeking is quite different in comparison to a Portfolio/ePortfolio developed for showing the change of students' learning over time (Butler et al., 2006; Barret, 2007). Thus, it is important to clarify early in advance the purpose of the ePortfolio as well as the audience.

For education, Abrami and Barret (2005) argue that there are three purposes of ePortfolios; Process, Showcase and Assessment ePortfolios. A Showcase ePortfolio involves the selection by the owner of final outcomes and achievements so as to be shared with peers, parents, potential employer. An Assessment ePortfolio is developed by its owner (usually in a structured way) so as to be assessed (typically summatively) by the teacher (or external evaluator). A Process ePortfolio is developed by its owner as a collection of work and activities so as to tell the story of the student's effort and progress in a specific area. Earlier, Zeichner and Wray (2001) referred to a slightly different classification of ePortfolio purposes; Learning, Credential and Showcase ePortfolios. Learning ePortfolio is quite similar to Abrami and Barret's (2005) Process ePortfolio. However, Credential ePortfolios is for Zeichner and Wray (2001) developed for certification purposes whereas Showcase ePortfolios for employability purposes.

Depending on the purpose of an ePortfolio, specific types of ePortfolio are developed (Klenowsky, 2002). For example, Fitch, Peet, Glover Reed and Tolman (2008) argue that the types of ePortfolios that research focus on are: process, reflective, assessment or evaluative, structured, integrative and showcase or professional. It is not intended in this report to provide an extended literature review of all types of ePortfolios. Even though all purposes and types of ePortfolios are important for students' learning, the Process/Learning, Integrative and Reflective ePortfolios seem to be more highly linked to formative assessment purposes as discussed earlier in Section 2 of this report.

Self-reflective skills and self-regulation are skills that are inevitably highly associated with the development of any ePortfolio and vice versa (Barret, 2007; Buckley, Coleman & Khan, 2010). Zubizaretta (2004, p.15) argued that ePortfolios aim *"to improve student learning by providing a structure for students to reflect systematically over time on the learning process and to develop the aptitudes, skills and habits that come from critical reflection"*. This was similar to what Barret (2003) called as *folio thinking*; a process that involves students' collecting, selecting, reflecting on and organizing artefacts of their work so as to demonstrate what they have learnt and what skills they have developed throughout the process. In addition, Reece and Levy (2009) argued that ePortfolios can help with the documentation of authentic learning activities and also enhance the communication and sharing of achievements and experiences with peers and others. In addition, Fitch et al. (2008), during an implementation of ePortfolios in a University found that the students valued the importance of an ePortfolio for their self-regulation as they reported ePortfolios helping them to organize their thoughts and self-assess their progress. This is also supported by Cheng and Chau's (2013) recent research that showed that 26 Undergraduate students' ePortfolio achievements were positively correlated to their higher order cognitive skills, their metacognitive skills and also collaborative learning strategies, concluding that in order for students to develop ePortfolios successfully, they need to have developed self-regulation strategies.

ePortfolios are by definition a personal collection and responsibility. Indeed, most researchers are concerned about the ePortfolios ownership and argue of the importance of the voice of the owner and the owner's first and foremost important role of deciding which items to share and to whom (Abrami & Barret, 2005; Barret, 2007; Fitch et al., 2008). However, as Rate (2009) indicated, when ePortfolios are implemented in early years of education, the ownership of an ePortfolio is more teacher-directed and as the school years pass by, it becomes more student-directed. In fact, most research on ePortfolios was conducted within Higher Education context where ePortfolios are more student-directed and work an additional 'tool' to reflect and monitor their learning (Butler et al., 2006).

Very little research was conducted in younger ages of learners and within an educational system that is tightly curriculum-driven. A very clear three-level process of implementing ePortfolio in K-12 schools so as to support assessment for learning is provided by Barrett's (2007) two-year implementations of ePortfolio involving approximately 6000 secondary students. Barrett (2011) suggests that schools wishing to implement ePortfolios to do it gradually bearing in mind the experience of both learners' and teachers. She highlights 3 levels of ePortfolio implementations: ePortfolio as Storage, ePortfolio as Workspace and ePortfolio as Showcase. ePortfolio as Storage can be an early adaptation of an ePortfolio in which students will work on collecting artefacts and material related to the area they are studying. As a next level, they can move to working on their ePortfolio as a Workspace by recollecting, modifying, connecting and organizing artefacts and material while at the same time reflecting on the learning process they are going through. This can be done with activities such as keeping a reflective journal. During this level, the teacher (and peers) provides feedback regarding the learner's work. Then as an extension of the Workspace level, learners' can move to the next level of presenting their work by selecting and organizing material to form a Showcase ePortfolio in respect to specific purposes and for a particular audience. In this level, the learner reflects on his/her achievements of specific goals/objectives by linking supporting documents in order to provide the evidence of those achievements. In her extended presentation of those three levels, Barrett (2011) uses Google Apps Education Edition Web 2.0 tools in order to demonstrate the type of activities students can get engaged with in order to form their ePortfolios.

Based on elements of Barrett's (2011) model, more recently, a research was conducted by the EU-Classrooms ePortfolio (EU-funded) project in which models of ePortfolios were explored and implemented in Secondary Education schools in six countries, using an open-source Portfolio platform (Mahara) and a customized version of Microsoft's Office 365. EUfolio's (2015) pilot evaluation results indicated that teachers' appreciated the implementations of ePortfolios as an approach that helped them collecting evidence of their students' learning and provide feedback to their students' work in a different way than in a traditional classroom and at the same time, some teachers argued that the ePortfolio implementations helped their students develop 21st century skills such as communication skills, reflective skills and critical thinking. In addition, teachers and project partners referred to the enhancement of formative assessment processes with the implementation of ePortfolios, highlighting however the challenge of developing more effective tools and techniques for tracking their students' learning and 21st century skills' development. EUfolio team and teachers also highlighted the importance of using a platform in which most of students' ePortfolio-related activities could be performed.

Furthermore, action research related to the formative (and in some case summative) use of ePortfolios in secondary education was conducted by other researchers as well; Chang et al. (2005) investigated the way 37 eighth-grade students used ePortfolio for five-month in Taiwan. Their results indicated that most students appreciated positively their assessment with ePortfolios, similarly to Baturay and Daloglu (2010) and Yusuf and Tuisawau (2011) findings. However, in Chang et al. (2005) research almost half of the students stated that the most difficult activity during the process was keeping a journal/diary. This was also supported by EUfolio's (2015) project results. Indeed, as seen earlier, keeping a journal/blog requires students developing their reflective skills that as discussed earlier are skills that teachers should emphasize on in order to enhance their students' self-regulation.

Another research was conducted by McLaren (2012) who investigated the implementation and development of ePortfolio by 165 primary and 140 secondary school students. The results of this research showed that ePortfolios were perceived by teachers as a good means for diagnosing and collecting evidence of students' learning and also indicated that teachers needed more training for performing formative assessment so as to enable their students providing effective feedback. In addition, teachers recognized the importance of developing their students' skills so as to be able to receive and provide feedback. In addition, Hung (2012) research concluded that the use of ePortfolios developed a sense of community within the classroom and enhanced peer interactions and peer-assessment. Furthermore, Janosik and Frank (2013) argued that their students felt that they learned more about themselves during their development of their ePortfolios.

Therefore, in respect to the formative assessment strategies of Wiliam and Thomson (2007) explained in Section 2, ePortfolios can be a medium to track and elicit evidence of students' understanding and at the same time activate students' as the owners of their own learning. During the process of developing and showcasing an ePortfolio, students can also set their own goals apart from the learning intentions shared by the teachers. If students share their ePortfolios with peers, then peers can be activated as learning resources for one another and students can receive feedback from various audiences depending on the purposes and type of ePortfolio. Thus, ePortfolios can be a technology (and a tool) for supporting students' internal and external formative assessment and feedback.

3.2. T&T for supporting (external) formative assessment and feedback

Apart from the specific tools that are used by teachers so as to enable students' self-regulation and internal formative assessment and feedback processes, several other tools exist that support teachers eliciting evidence and providing feedback of their students' learning process and in addition, facilitate students receiving feedback from several sources. In this section, Computer-based Assessment and Testing, Classroom Response Systems, Technology-Enhanced Learning Environments and Educational Data Mining / Learning Analytics will be discussed in respect to their affordances for formative assessment process.

3.2.1. Computer-based Assessment and Testing

One of the most common ways that technology was used for assessment purposes involved students taking tests using a computer through systems with various labels; Computer-Based

Assessment (CBA), or Computer-Aided Assessment, or Computer-Based Testing (CBA) procedures (van der Kleij, 2013). These computer-based assessment procedures were initially designed for summative assessment purposes as a set of multiple-choice questions that students were able to read through a computer screen and then clicked on their perceived correct answer (van der Kleij, 2013). Then the system would have proceeded to the next question until the users finished with the test and provided a total score number as feedback, sometimes displayed the correct answers to the incorrect responses. Current developments, however, allow such systems to be intelligent, in the sense that they can provide students with richer and immediate feedback, as a simple score number or even an indication of the incorrect answers is not effective for formative assessment purposes (Zou & Zhang, 2013; Goodman & Hamplenton, 2004; Landauer, Lochbaum & Dooley, 2009). Research of undergraduate students who took online multiple choice tests and received immediate feedback on their weaknesses and information on how to overcome them indicated that they performed better than students who did not take those tests (Buchanan, 2000).

In some cases, the integration of specific technologies and tools, such as computer-assisted assessment systems, can change the way students receive feedback. In his dissertation, van der Kleij (2013) investigated and compared the type, level and timing of feedback in computer-based formative assessment. Following the classifications of two important reviews of literature (Shute, 2008; Hattie & Timperley, 2007), van der Kleij (2013) classified feedback in respect to type, timing (Shute, 2008) and level (Hattie & Timperley, 2007) producing a representation of the relationship between type, level and timing of feedback, that forms the feedback's content as shown in Figure 9 below.

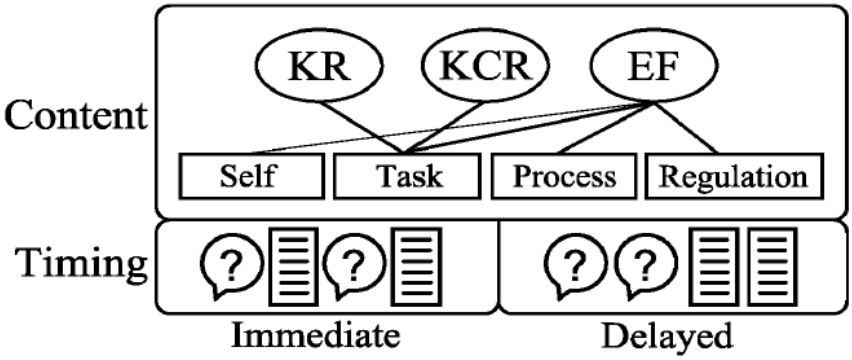

FIGURE 9: VAN DER KLEIJ (2013, P.9) REPRESENTATION OF TYPES OF FEEDBACK LINKED TO TIMING AND LEVEL

As explained by van der Kleij (2013, p. 8-9), Shute (2008) refers to simple feedback type as 'knowledge of response' (KR) in which students are informed whether their answer is correct or not. A more complex type of feedback that extends the information given to students to include the correct answer is referred to as 'knowledge of correct response' (KCR). Shute (2008) then classifies any feedback that provides more information than KR and KCR as *'elaborated feedback'* (EF). Feedback can also be classified according to the level that feedback aims; self, task, process and regulation (Hattie & Timperley, 2007 following the model of Kluger & DeNisi, 1996). KR and KCR feedback relate only to the task level whereas the EF aims at the learner's characteristics (self), the processes within the learner's mind (regulation) and the process followed to complete the task (process). As shown in the representation, KR and KCR can form immediate type of feedback whereas EF can be either immediate or delayed depending on the level that it aims at. Van der Kleij

(2013) suggests that in order for computer-based formative assessment to be effective, computer-based intelligent assessment systems need to consider the integration of EF responses to students and not just KR and KCR as most systems integrate.

Indeed, research supports that the use of EF type might be more effective; in their research, Zou and Zhang (2013) investigated the effect of a new score report mechanism on 237 EFL (English as a Foreign Language) students' self-regulation in relation to English. Students in their study used web-based formative tests that provided them with not just their score number but also *"sub-scale scores, their percentile position, as well as corresponding feedback on self-regulation strategies"* (p. 54). They reported that when compared to the traditional score report, the new score report had a positive effect on students' self-regulation strategies as students had set clearer learning goals, were more motivated and demonstrated reflective skills.

Furthermore, several approaches of web-based formative assessments that can be used in an online learning environment emerged during the past decade. As it was already mentioned in Part 2, in order for feedback to be effective, it needs to be 'timely' effective so as to help students rethink and revise their work (Buchanan, 2000; Bransford et al., 2000). Thus, researchers started taking advantage of technology's affordances of providing immediate and repeated feedback. For example, Gardner, Sheridan and White (2002) reported students' satisfaction with the use of a web-based formative assessment multiple-choice testing system (CECIL) that allowed students to take and repeat tests online through an e-learning platform as a way to self-assess their understandings. Similarly, Kahn, Davies and Gupta (2001) reported that the use of Questionmark system helped students self-monitor their progress.

An interesting system of web-based formative assessment was developed by Wang, Wang, Wang & Huang (2004). Wang (2007) reports on the effectiveness of a Web-based Assessment and Test Analysis System (FAM-WATA) that was used by 503 seventh-graders in Taiwan. The FAM-WATA system was created to help teachers administering multiple-choice formative assessment and to help students self-assess their skills and understandings through six strategies; i. *repeat the test* (students are able to repeat a previously completed test)*, ii. correct answers are not given* (students can take a test but they do not receive the correct answers)*, iii. ask questions* (students are allowed to ask questions to teachers or peers regarding the test they are taking), iv. *monitor answering history* (students – and teachers – can get a report of their answer history in various tests after they pass them)*, v. Query scores* (students can view the answers of others, such as their peers so as to check their progressions in respect to the progression of their peers) and vi. *All pass and then reward* (students receive an animated accomplishment effect so as to congratulate them for passing their tests) *strategies.* The results of Wang (2007) research indicated that: the use of embedded web-based formative assessment systems in online environments was better than a paper-based formative assessment, the use of such web-based formative assessment with the six strategies described above (FAM-WATA) was significantly better than the web-based formative assessment system without the strategies and paper-based formative assessment. In Wang's own words, (2007, p.183) *"if a web-based assessment can be equipped with additional instructional strategies such as those designed into FAM-WATA, learning effectiveness in the e-learning environment will be significantly enhanced"*.

3.2.2. Classroom Response Systems

When teachers ask questions in the classroom they cannot have a clear picture of what all their students are thinking. In order to make it explicit, teachers started using small whiteboards or other boards so that when they ask the questions, students can make their thoughts explicit by writing their answer/response on the board. This way, teachers are able to get a clearer idea of the classroom's status. However, this activity became richer, when researchers on the field of formative assessment started investigating the pedagogical potentials of Classroom Response Systems (CRS) technologies. CRS mainly help teachers set questions to students and poll their answers in the classroom. CRS (sometimes called 'electronic voting systems', 'classroom communication system', 'learner (student) response system' or 'clickers') typically involve the use of a number of input devices (i.e. clickers, handheld devices) that students have (Figure 10), which are wire- or wirelessly-connected to the teacher's computer using related software (Beatty & Gerace, 2009). When teachers set a question, students input their answer by clicking the appropriate key on their device and answers are displayed simultaneously on the teacher's computer/device, usually in the form of a bar chart graph, displaying what the classroom voted/answered (Abrahamson, 2006; Beatty, 2004; Burnstein & Lederman, 2003). During the traditional raise-my-hand students' response to teacher's questions, students are sometimes reluctant in sharing their thoughts in the fear of being incorrect, whereas through a CRS integration, responses are typically anonymous (Skiba, 2006; Caldwell, 2007). Most recent developments of CRS software, however, allow teachers the ability to identify the responses of each individual input device, and thus a student (Beatty & Gerace, 2009).

FIGURE 10: EXAMPLES OF CRS (UNTITLED ILLUSTRATION OF COMPUTER RESPONSE SYSTEM DEVICES)

It is argued that CRS implementations can promote learning within social constructivist, constructivist and metacognitive learning paradigms (Masikunas, Panayiotidis & Burke, 2007). Several pedagogies have been developed in order to support the integration of CRS in the classroom for formative assessment. Mazur (1997) investigated the effect of 'Peer Instruction', a CRS-supported pedagogy that involved the regular use of CRS-supported multiple-choice tests, ConcepTests, in a classroom regarding taught material. If the majority of students had failed in providing the correct answer, then a discussion of the matter initiated. He found a positive impact on students' engagement and learning through Peer Instruction and at the same time this approach provided teachers with feedback regarding students' understandings. The effectiveness of this CRS-supported pedagogy was also supported in later research, using pre/post-tests to show the gain that the students had (Fagen, Crouch & Mazur, 2002). Other researchers suggested pedagogies to support the use of CRS in a classroom, such as Dufresne, Gerace, Leonard, Mestre and Wenk (1996)

and Dufrense, Gerace, Mestre and Leonard (2000), who introduced the *Assessing-2-Learn* pedagogy that involved a cycle of inquiry-based questions which Beatty and Gerace (2009) elaborated more in their development of TEFA as a pedagogy behind the use of clickers in science classrooms (See Section 2.4). Research regarding Assessing-2-Learn, Peer Instruction and TEFA pedagogies showed that indeed both students and teachers benefited from their implementations in high school or higher education (Beatty & Gerace, 2009). In addition, the implementation of CRS and the immediate share of students' responses in the classroom allow students to compare their selves with their peers as they can see where they stand in relation to the rest of the classroom (Masikunas, Panayiotidis & Burke, 2007). What all those pedagogies had in common was the use of CRS in order to collect evidence of students' understandings on the fly by asking specific and challenging questions, to present students' responses in the whole classroom through representations (i.e. charts) so as to enable and enhance classroom discussion, allowing this way both teachers and students to go through a peer-assessment process as well as a self-assessment reflection of asking 'where am I now'?

However, the development of those pedagogies was emerged within Science and Physics education. More recently, researchers have tested TEFA and CRS-supported pedagogies in other subjects with various outcomes. For example, Galal et al. (2015) investigated the effect of Student Response Systems (SRS) on learning achievements and also attitudes and perceptions of the use of such systems of first year pharmacy students at a University. Their research indicated that SRS use did not significantly increased retention of material related to the course but SRS had an effect on treatment students' attitude and perceptions towards the technology, in comparison to the control group. In contrast, Simelane and Mji (2014) reported a positive impact of a technology-engagement teaching strategy with the aid of clickers on student's academic performance on mathematics. Additionally, Sheard and Chambers (2011) investigated the effectiveness of a form of technology-enhanced formative assessment CRS that they named 'Questions for Learning (QfL)' on students' mathematical learning achievements. For this research, students were presented with a sequence of questions using a CRS self-paced device. Each student could proceed at his/her own pace and information regarding their responses appeared on the teacher's computer allowing him/her to formatively assess their students' understanding, intervening where it was needed. Their results showed that through this approach, students' mathematical learning achievements were improved.

In a similar implementation, the same researchers, Sheard and Chambers (2014) investigated the effectiveness of a similar QfL approach on students' grammatical knowledge and writing in order to explore formative assessment's quality assurance. Their research was conducted in 42 primary schools, in which 21 were the experimentation sample and the other 21 was the control group. They found that the use of QfL approach through CRS hand-held devices and LearningClip tool[7], had a statistically significant positive effect on students' grammatical knowledge (effect size = 0.16) that was also transferrable in writing. In addition, teachers were able to collect evidence of their students' ongoing understandings. For example, Ribbens (2007) describes the way his use of students' aggregated responses helped him formatively assess his teaching, allowing him to make an informative decision on whether to reteach the lesson or move on to the next topic whereas

[7] "…LearningClip, a privately owned limited company producing online resources for teaching primary maths" (Sheard & Chambers, 2014, p.16)

Skiba (2006) refers to similar benefits from the use of aggregated students' responses with the use of CRS in the classroom. In addition, Nicol (2009) emphasizes that the use of Electronic Voting Systems in a process where teachers asks questions, students response with their handheld devices and teacher shares the classroom's responses in a form of a bar chart, asking students to discuss their responses with their peers can support "*three types of feedback in the same class session: feedback through reflection where students compare their own MCQ (Multiple Choice Question) response to the responses of the class (bar chart), peer feedback through discussion and teacher feedback*" (p. 345).

However, Nielsen, Hansen-Nygård and Stav (2012) suggest that teachers should focus on explaining why an answer is correct and another is incorrect, providing opportunities for quality of feedback during classroom discussion (Sheard & Chambers, 2014; Gardner, 2012). Indeed, Boyle and Nicol (2003) argued that, perhaps, the effectiveness of the immediate feedback students receive through the use of such technology is relied on the richness of the discussion that follows the quantitative results of the students' responses. Thus, the role of the teacher as the discussion facilitator, in using CRS in the classroom is very important. Yet, as Sheard and Chambers (2014) reported in their research, even though teachers (and students) received instantaneous feedback regarding students' understanding that resulted in teachers adapting their teaching, it seems that teachers' needed time to reflect on the information they elicited through the QfL sessions with the use of CRS devices so as to implement in subsequent lessons. As the authors (p. 22) stated: *"additional professional development to facilitate more immediate interpretation and synthesis of data to inform the explicit identification of future learning targets and teaching strategies would be beneficial".* This echoes findings of Charlesworth (2012), who reported teachers' lack of awareness in respect to the pedagogical benefits of the use of CRS in their classroom and limited skills in respect to setting up and using a CRS for formative assessment. Thus, when teachers decide to use CRS in their classrooms they need to plan in advance the type of questions that students will be asked and the type of feedback teachers will provide to students so as to assure quality of formative assessment and feedback (Sheard and Chambers, 2014; Gardner, 2012).

3.2.2.1. Interactive Networked Classroom Assessment Systems (INCAS)

Despite the fact that the use of CRS seems promising for formative assessment (Fies & Marshall, 2006) CRS technology on its own does not guarantee effective formative assessment as the teacher's role is highly important. For example, Nielsen, Hansen-Nygård, and Stav (2012) argue that when teachers collect students' responses of multiple-choice questions, they get a number of correct responses that does not necessarily mean that they collect a correct image of their students' understandings. They only get that a number of students voted for the correct answer but do they really know whether their students understood why that answer was correct? This might explain why some studies that used CRS showed no gains in students' achievements, such as Lasry's (2008) investigation of the use of 'clickers' incorporating Mazur's Peer Instruction (1997) in an undergraduate course when he compared the overall average of the students' pre/post-tests instead of the individual students' understandings. In contrary, research of CRS following a respective pedagogy that enables classroom discussion and further elaboration of students' understandings, such as the ones referred earlier and also Yourstone, Kraye and Albaum's (2008)

intervention of classroom discussion immediately following the use of clickers, demonstrate positive effects of such a technology on students' learning.

A technology that can be considered as an evolution of CRS is the Interactive Networked Classroom Assessment Systems, such as for example the TI-Navigator™ system that works similarly to a typical mathematics graph calculator allowing teachers to set instructional questions/tasks in other formats besides multiple-choice quizzes, such as functions and graphs, and receive multiple types of responses as correct answers (Stroup, Carmona & Davis, 2005). The effectiveness of TI-Navigator™ system was researched in a research of more than 100 classrooms within the Classroom Connectivity in Promoting Mathematics and Science Achievement study indicating positive effects (effect size = 0.37) on treatment students' achievements in algebra (mathematics) in comparison to the control group Pape, Irving, Owens et al. (2008). Pape et al. (2008) as well as Stroup et al. (2005) highlighted the advantages of such multiple representations of both tasks and responses in respect to eliciting of evidence of students' understandings and feedback as such interventions resulted in rich classroom discussions during teaching.

3.2.3. Technology-Enhanced Learning Environments

When technologies moved from Web1.0 to Web2.0 the important component of communication enhanced the nature of technology and technological tools. Inevitably, educational technology advanced into considering online ways of teaching through Technology-Enhanced Learning Environments (Carneiro, Lefrere, Steffens & Underwood, 2011). During the past decade, literature investigating the integration of Technology-Enhanced Learning (TEL) approaches and Technology-Enhanced Learning Environments (TELE) in education has been increasing. TEL conceives of all those learning situations where "technology plays a significant supportive role" (Goodyear & Retalis, 2010, p.vii). TELEs are technology-based environments that can support learning (skills and knowledge acquisition) that emerges during students' interaction with a teacher/facilitator, their peers, supporting - online - material and other technological resources that are composing the learning environment (Wang & Hannafin, 2005; Aleven, Stahl, Schworm, Fischer & Wallace, 2003; Carneiro, Lefrere, Steffens & Underwood, 2011). These environments – typically – involve a platform that users can log in with a unique account and use the WWW in order to establish interaction between users and also the learning resources and material (Wang & Hannafin, 2005). Most TELEs can be used in multiple devices, such as a computer, a tablet, a smartphone etc.

Wang and Kinuthia (2004) argue that Technology-Enhanced Learning Environments have four characteristics: *"using technology to motivate people, using technology to enrich learning resources, using technology to implement learning and instructional strategies and using technology to assess and evaluate learning goals"* (p. 2725). Indeed, as an extension of Computer-Mediated-Communication (CMC) technologies, most Virtual Learning Environments (VLE), e-learning platforms, Learning Management Systems (LMS) and other web-based learning environments use the WWW so as to support a learning environment that can facilitate the characteristics of a technology-enhanced learning environment as described by Wang and Kinuthia (2004) above. Either these environments are used for online learning or as a blended learning (combination of online and face-to-face teaching and learning), research has argued that their technological and pedagogical affordances can support teaching, learning and assessment (Johannesen, 2013; Limniou & Smith, 2010).

A range of TELEs that are being used for education is discussed in literature, yet most of the related empirical research was conducted in higher education, through the Institution's e-learning environments (Wang & Hannafin, 2005). This section will discuss in particular two TELEs that are mostly discussed in literature in relation to formative assessment processes; Virtual Learning Environments (VLE) and Learning Management Systems (LMS).

Advances in technology inevitably affected distance education practices with the use of systems that allow the teacher/facilitator to interact with students online, through the use of – usually – a web-based platform (Lazakidou & Retalis, 2010). Virtual Learning Environments (VLEs), Learning Management Systems (LMS) and Computer-Mediated Communication Systems (CMCS) are examples of such systems. Despite the fact that VLE and LMS are different systems, they are often being used the same way in literature related to e-learning and distance learning. For example, LMS, such as Microsoft's SharePoint, Dokeos and ELearning Manager are often being used by a broader audience such as organizations and industrial institutions so as to manage and track their employees' learning and training, whereas VLEs such as Moodle, WebCT and Blackboard are being used mostly by educational institutions – mainly higher education institutions (Johannesen, 2013). Both VLE and LMS have similar functions; They can both offer the opportunity to the teacher to create learning content material, share it with the students and collect evidence of their students' online performance through analytics provided by the systems (Goodyear & Retalis, 2010). They can offer a range of tools that can be used to support learning, such as discussion forums. Nonetheless, LMS mostly focus on providing an environment for managing learning, for example monitoring an individual's (i.e. employees) training and progress whereas VLE environments offer such monitoring and also more opportunities for collaboration either with the teacher or with peers, with the use of Wikis, Blogs and in some cases, the creation of webpages (Nicol & Milligan, 2006; Johannesen, 2013; Hatzipanagos & Warburton, 2009). However, because of the embracement of the use of online platform technologies in education, IT-related companies, such as Microsoft and Google, have recently started developing their non-educationally-oriented products so as to assist teaching, learning and assessment. For example, the adaptation of Microsoft's LMS SharePoint as Office365 is being adapted and used in some schools and Universities as an LMS/VLE that helps teachers creating and sharing content with their students and, as it was recently reported, as an ePortfolio environment where students can develop their ePortfolio using the various tools that Office365 includes, such as OneNote (EUfolio, 2015). It is not a goal of this report to argue on the effectiveness of VLE in comparison to LMS or a specific product over the other. Rather, since both terms are often used the same way in literature, the term VLE will be used from now on in this report, meaning a technology-enhanced online learning environment that can have both VLE and LMS functions.

Research argues that, especially for higher education, the use of VLE can help teachers identify students that are at-risk as they are able to collect evidence of their participation and track their activities when mining data from the platforms (Macfadyen & Dawson, 2010). In fact, it has been proposed that data provided from online VLE, such as Backboard and Desire 2 Learn, can be an early indicator of a students' academic performance (Wang & Newlin, 2002). This is also supported by Campbell and Oblinger (2007) who indicated a significant relationship between usage patterns within LMS and students' achievements. It has been argued that the use of VLEs can increase students' participation and motivation (Nunes & McPherson, 2003), enhance interaction between

students and teachers and also between peers (Lonn & Teasley, 2009) and at the same time, shifting the focus of teaching and learning towards a more student-centered approach (Vogel & Klassen, 2001).

Furthermore, research in higher education supported that the use of VLEs can be a tool for peer assessment and students' collaboration (Barbera, 2009). In addition, the use of a VLE enhances students' self-regulation (Nicol, 2007). Johannesen's (2013) research of the use of VLE in primary education argued that teachers might be able to assess higher order skills, such as metacognition, creativity and communication skills that students develop through their interaction with a VLE and its tools. In addition, she reported evidence that *"VLE supports a teaching practice for new educational goals and innovative formative assessment methods, in particular the use of digital portfolios as a tool to support processes of self-assessment and self-regulation"* (p.311).

A very important advantage of a VLE is the fact that it can be configured in respect to the purposes that it is needed. For example, if an organization/school/institution plans in using a VLE in a teacher-centered or organizational manner, such as only sharing material with students (and/or staff and parents) and collecting analytics of user's logs and quantitative responses, then they can change the environments' settings so as to facilitate only such functions. However, research has indicated that when teachers used a VLE (Blackboard) to share material, announcements and assignments to engineering school students, students in fact preferred a more interactive VLE in which they could collaborate with their peers and actively participate in their learning (Limniou & Smith, 2010). In the same research, students valued the importance of receiving teachers' feedback from tutors through the VLE assessment tool and both teachers and students valued the importance of their participation in discussion boards with their peers and teacher. Indeed, several studies have shown the importance of providing opportunities for social interaction through online media, creating this way authentic learning environments and communities of practice (MacDonald, 2004; Wenger, 1998; Wang et al., 2012; Keppler et al., 2006). In fact, as reported in literature, most VLE now have a suite of tools that a teacher can integrate in their online/blended courses in order to facilitate effective formative assessment process and feedback. Moreover, VLEs like Mahara, are particularly developed to support ePortfolios, by adapting as a first guiding principle that it is learner centred, providing the learners with tools to support a Personal Learning Environment (Mahara, 2016).

VLE integrated tools to facilitate formative assessment

There are many tools integrated in a VLE. However, the most commonly discussed in literature related to formative assessment are: Discussion boards/Forums, Wikis, Blogs, Online quizzes and Learning Analytics. Blogs and Wikis have already been discussed in Sections 3.1.3. and 3.1.4. respectively. Learning Analytics will be extensively discussed in the next Section 3.2.4. Thus, in this section, more emphasis will be given in the discussion of literature related to Discussions boards/Forums. Nonetheless, it is worth mentioning that Wiki authoring and Blogging tools provided within a VLE that users are already registered in, can potentially be a more powerful tool in the hands of the teacher as it allows similar functions and features of wiki editing and blog sharing within the same environment that students participate for other learning activities such as Forum discussions and accessing related online material (Ng, 2014). In addition, the use of blogs within a

VLE limits the exposure of the blog's content to the community of users within the VLE, allowing teachers and students to use such tool mostly as reflective journals (Nicol & Milligan, 2006).

3.2.3.1. Discussion boards/Forums

Discussion boards or Forums (from this point forward 'Forum' will be used) are tools that allow discussions between users within a VLE. A user (typically the teacher) posts a thread in a Forum and asks students to reply to this thread. Students can then reply to the original post or reply to replies from other users, expanding this way an asynchronous online discussion. Following a social constructivism approach of teaching and learning, teachers can use Forums so as to create learning communities that provide opportunities for potential peer feedback, sharing and responding, in their online classrooms (Keppler et al., 2006; Bransford, Brown & Cocking, 2000). In addition, research has shown that discussions within a Forum allow teachers to share assessment criteria (Heinrich, Milne, Ramsay & Morrison, 2010) and provide general exemplar feedback towards the entire classroom that can be beneficial for each individual student as well (Prins, Sluijsmans, Kirschner & Strijbos, 2005).

In particular, Handley and Williams (2011) investigated undergraduate students' interaction with a databank of exemplars of assignments with annotated feedback comments that were shared to them through the University's VLE (WebCT) and were asked to participate in online discussions through the VLE's Forum tool. Using results from both a survey and the VLE page-tracking data, they found that students used the databank significantly (approximately 4 hits per student) and found it useful. In addition, teachers valued the fact that they could share the assignment criteria to students and provide them with 'real' examples to consider in a formative way before submitting their final assignments. However, the authors indicated that even though students appreciated the use of exemplars as a reference for sharing, discussing and understanding assessment criteria, they preferred the spontaneous environment of the physical classroom rather than to *"…expose their questions to public online scrutiny"* (Handley & Williams, 2011, p.106) as there were several misinterpretations of the feedback that was annotated in those exemplars. Thus, the initiation of online classroom discussions within an online environment needs to be carefully planned and executed so as to develop a shared understanding among the community of practice and avoid such interpretations (Handley & Williams, 2011; Wenger, 1998).

In respect to the exposure effect that students' work can have within an electronic sharing system, VLEs, such as Moodle, allow for the addition of plug-ins that can enhance interaction between peers and teachers. For example, Bhalerao and Ward (2001) developed a peer-assessment system tool that could be used within a VLE, allowing students' written work to be anonymously distributed within a group and returned to the original author, after being assessed (feedback and comments) by peers. Thus, students have the opportunity to provide and receive feedback anonymously and teachers can monitor the entire process through the VLE (Nicol & Milligan, 2006).

As indicated by the suggested strategies for effective formative assessment, teachers can use the Forums, not for just sharing the assessment criteria, but also for creating online space where students can openly discuss assessment criteria and ask questions regarding their assignments freely (Palloff & Pratt, 2005). Teachers can then gather all students' misunderstandings and create (also in collaboration with the students) a rubric for the assessment criteria which they can also

upload online and further discuss it in a Forum (Nicol & Milligan, 2006). Apart from helping the teacher 'capturing' students contributions to online discussions, the use of such asynchronous communication tools such as Forums, can help students reflective process, as they are able to revisit what is written in the Forum and reflect on their responses and also assess what others have written (Lea, 2001).

The use, host and setup of VLEs require some cost for schools. This resulted in attempts to use freely accessible tools that allow online discussions and sharing, that are already embraced by students, such as the use of Social Networking Sites, like Facebook (Wang et al., 2012). The results of related research indicate mixed outcomes. For example, Schroeder and Greenbowe (2009) reported that when students were asked to use WebCT Forum as a compulsory discussion tool and also Facebook as an optional one, students seemed to use Facebook more frequently, with posts that resulted in more complex discussions of topics. However, a study conducted by DeSchryver et al. (2009) where they compared students' participation and discussions in Moodle and Facebook, showed that in fact, students preferred using Moodle's Forum rather than Facebook groups for their discussions, as they did not participate more frequently in Facebook as they did not like the use of a separate platform for discussing, indicating their preference of discussions within a VLE that they have already been using in their lessons. Wang et al. (2012) research of using Facebook as an LMS concluded that even though students were satisfied with Facebook group affordances they did not feel safe as their privacy could be violated since they were using their personal Facebook accounts, something that it is also supported by Jones, Blackey, Fitzgibbon & Chew (2010). The authors (Wang et al., 2012) also reported a number of limitations of Facebook as an LMS; discussions could not be threatened as in a bulletin board, certain files format could not be uploaded.

3.2.4. Educational Data Mining and Learning Analytics

Bienkowski, Feng and Means (2012, p.5) claims that*: "education is getting very close to a time when personalisation will become commonplace in learning"*. One way of achieving such personalization is with the use of Analytics. Analytics is a term that is most frequently found in the business sector, in which several companies and organizations acquire and analyze big data regarding their business in order to improve their performance (Siemens, 2013; Baker & Simenes, 2014). Through such a process, organizations make data-driven formative decisions that can potentially increase their productivity and employees' motivation, after going through a process of gathering data, analyzing those data so as to identify patterns and predict future actions (Manyika, Chui & Brown et al., 2011). During the 2000s, several higher education institutions started implementing *academic analytics* in order to *"manage the academic enterprise"* (Goldstein, 2005, p.2; Siemenes, 2013). However academic analytics have been mostly used so as to help academic institutions organize their resources and employees and also improve efficacy within the institutions rather than assisting teachers and students to improve teaching and learning processes (Siemens, 2013). Indeed, with the increasing use of VLE/LMS and other web-based technologies for education, the adaptation of data-mining analytics has been used so as to inform teaching and learning (Siemens, 2013). Two major fields in educational research have been involved with the use of analytics for educational purposes; Educational Data Mining (EDM) and Learning Analytics (LA). In this report, EDM and LA will be discussed in relation to their potentials for formative assessment in education. But first it is important to clarify the terms.

3.2.4.1. What is EDM and LA and who is it for?

The definition of Learning Analytics that is mostly used in literature is the one given by the 1st International Conference of Learning Analytics and Knowledge (2011, homepage) website in which they define it as: *''the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs''.* As it can be seen from the definition, Learning Analytics is an approach that does not only aim in understanding and improving the environment that tries to analyze. Rather, it highly involves learners as it puts forwards the specific aim of optimizing learning. Comparing the processes listed in the definition of LA to the key principles and definitions of formative assessment, it seems that LA can support formative assessment processes in education.

EDM, as a field has many commonalities with LA field and this is why sometimes the two terms are being used meaning the same processes and techniques. Nonetheless, EDM is more focused on reductionist analysis' techniques of exploring and analyzing the simplest mechanisms of complex situations, whereas LA is considered as extending EDM methodologies in the sense that it draws on EDM techniques so as to make sense of situation and provide evidence for action initiations (Siemens & Baker, 2012; Siemens, 2013). In addition, EDM researchers focus mostly on automated methods for investigating educational data whereas LA researchers focus mostly on methods that humans use in order to explore educational data (Baker & Siemens, 2014). In other words, EDM research focuses mostly on developing techniques so as to automatically explore and analyze large data collections coming from educational context (Romero, Ventura & Garcia, 2008) and LA focuses mostly on ways of collecting such evidence, sometimes applying such EDM techniques, so as to understand and improve learning and teaching (Siemens, 2013).

EDM is one of the steps of Knowledge Discovery in Databases (KDD) process (Klosgen & Zytkow, 2002) of extracting interesting patterns in large data collections. Using data mining techniques that industries are using, for eliciting data from educational contexts, including conventional teaching classrooms and also web-based environments is in plain words Educational Data Mining (Romero and Ventura, 2007). Romero and Ventura (2007, p.136) claim that *"Data mining techniques can discover useful information that can be used in formative evaluation to assist educators establish a pedagogical basis for decisions when designing or modifying an environment or teaching approach".* To help understanding the way EDM works, Romero and Ventura (2007, p.136-137) presented the following iterative cycle of processes (Figure 11).

Following the results found in their survey of literature, Romero and Ventura (2007, p.136-137), state that academics and educators are responsible for designing, building and maintaining an educational system (set either traditionally in a classroom, set online or blended) that students use by participating, interacting and communicating. In this cycle, data from students' usage and interaction with the content and the learning environment are aggregated and are used so as to inform several actors involved in the learning process; students, academics/educators, administrators/stakeholders (Romero & Ventura, 2007). When data mining processes are oriented towards users (students), they provide them with recommendations regarding resources, learning activities and learning paths that the users might want to follow in order to improve their learning (Tang & McCalla, 2005). When data mining processes are oriented towards the

academics/educators, they provide them with more objective feedback in respect to their instruction, as they can receive valuable information regarding their course content, their students' response to their instruction approaches and also, acquire information regarding their students' activities and patterns of behaviour within the educational system, helping educators to adapt their teaching accordingly (Hamalainen et al., 2004; Romero & Ventura, 2007). Data mining processes can also inform administrators regarding the educational system's effectiveness by providing, for example, information about the users' patterns and matters of accessibility to resources (Grob, Bensberg & Kaderali, 2004).

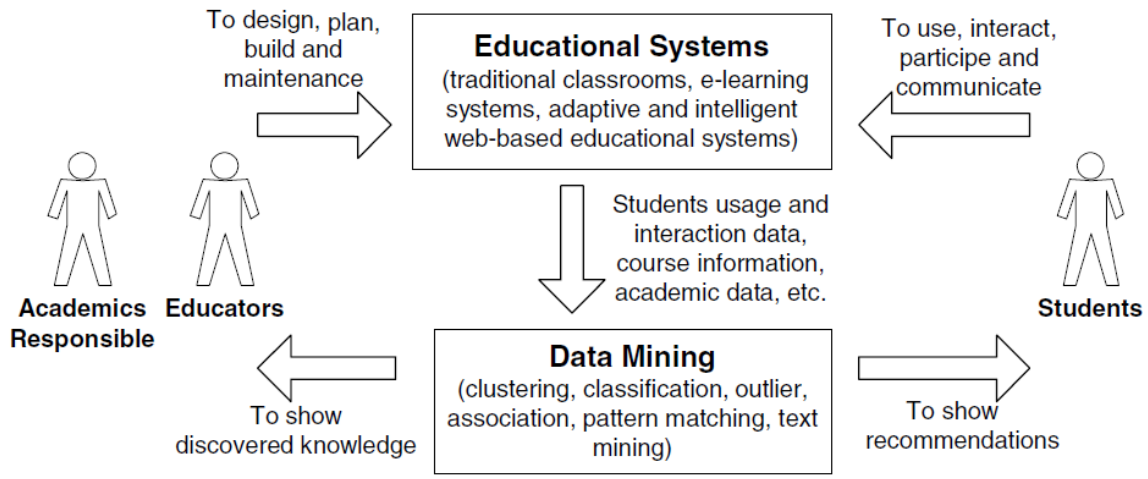

FIGURE 11 ROMERO AND VENTURA (2007, P.136) CYCLE OF APPLYING DATA MINING IN EDUCATIONAL SYSTEMS

Even though most of the EDM-related research is mostly concerned with applications of analytics in web-based (or other electronic) environments, this is not necessarily always the case. As Romero and Ventura's (2007) survey of literature indicated, teachers are able to gather such data in traditional face-to-face teaching environments through, for example, observations of students' response and behaviour, tracking students' attendance, paper-based monitoring, historical data analysis and evaluations of the pedagogical effectiveness of their teaching strategies. However, EDM in web-based (or electronic) environments can be much more easier and also more powerful as they can collect, record, organize and analyze data of students' activity in a more automated way (Romero, Ventura & Garcia, 2008).

3.2.4.2. Examples of EDM/LA from literature

Research in EDM and LA for education is ongoing and a number of research projects have developed frameworks, models and tools that can be used to enhance teaching, learning and assessment. Romero and Ventura's (2010) updated survey of more than 300 papers related to EDM research indicated 11 applications/tasks in educational contexts that that have been carried out with EDM techniques and applications: Analysis and Visualization of data, Providing feedback and supporting instructors, Recommendations for students, Grouping students, Predicting students' performance, Social Networking Analysis, Detecting undesirable student behaviours, Student modeling, Developing concept maps, Constructing courseware, Planning and scheduling. The discussion of literature that follows illustrates mostly the first 7 applications as the 4 rest are distributed within those 7.

- *Analysis and Visualization of data*

The use of statistics and visualization tools allow teachers to capture an overall summary report of users' usage and activities in a web-based educational system (Romero & Ventura, 2007). However, because most data mining tools were originally developed for business sector, such tools produce complicated statistics' reports can be particularly overwhelming for teachers, especially when it comes to interpret statistics of large data (Romero & Ventura, 2010; Ali, Asad, Gasevic et al., 2013). In fact, teachers prefer using simple statistics' reports that are related to education, such as reports of overall success rates and account of material read by students (Zinn & Scheuer, 2006). For this reason, several research projects have developed specific EDM tools such as Synergo/ColAT for providing statistics (Avouris et al., 2005) and GISMO/CourseVis for visualizing educational data (Mazza & Milani, 2005).

In addition, Verbert, Duval, Klerkx et al. (2013) who's work focuses mostly on the micro-level of teachers' and students' activity within open-learning contexts (Govaerts, Verbert, Dahrendorf et al., 2011) introduced learning analytics dashboards as a new application of learning analytics that enables teachers and students to visualize students' traces. They proposed a conceptual framework to help analyzing such learning analytics applications for learning and teaching. Their process framework model illustrates four stages: awareness, reflection, sensemaking and impact; First, data is being visualized using activity streams, graphs and other visualization tools making users aware of their activities; Then, users ask questions and reflect on the way such visualizations are useful to them and then provide new insights in their attempt to make sense of their reflections, so as to, lastly, decide whether to change their behaviour or induce new meanings accordingly.

- *Providing feedback for supporting instructors and Grouping students*

In addition, EDM tools can provide feedback for supporting instructors, through the use of web-mining techniques so as to extract data and knowledge from the web that can be applied by teachers in order to evaluate the structure and content of their educational websites and systems (Srivastava et al., 2000). Web-mining techniques can be clustering and classification (Klosgen & Zytkow, 2002) for grouping students' activities and performance as well as grouping similar educational content (Romero & Ventura, 2007) and also, outlier detection of patterns that can help teachers identify students that are facing difficulties. Another way is with the use of association rule mining and sequential pattern mining (Agrawal, Imielinski & Swami, 1993; Agrawal & Srikant, 1995; Romero & Ventura, 2007) that can allow teachers elicit evidence of students' access in content and tools, as well as their patterns of using them within a web-based learning environment. In addition, the use of text-mining techniques can help teachers assess asynchronous discussions conducted for example in a Discussion Board or Forum and also the progress of such discussions in collaborative activities captured electronically (Dringus & Ellis, 2005; Ueno, 2004; Agudo-Peregrina, Iglesias-Pradas, Conde-González, & Hernández-García, 2014).

- *Recommendations for students*

Furthermore, EDM techniques such as the association rule mining and sequential pattern mining techniques mentioned above, can provide students with recommendations regarding the learning materials that are most suitable for them (Markellou, Mousourouli, Spiros & Tsakalidis, 2005). In addition, EDM applications can support learners since they can identify learner's needs and

automatically adapt the learning environment so as to personalize the learning experience (Baker, Corbett, Koedinger et al., 2006).

- *Predicting students' performance*

Additionally, it has been argued by many researchers that the use of LA and EDM techniques so as to collect data of students' demographics, participation and social activities, emotional and other behaviours, can help predicting their academic performance and significant lack of skills (Credé & Niehorster, 2012; Manyika et al., 2011). The ability to group students' behaviours within a web-based learning environment helps teachers evaluate the current status of their students and predict their learning performance, so as to provide students with the appropriate scaffolding (Romero & Ventura, 2010). Furthermore, MacFayden and Dawson (2010) found that using some LMS/VLE variables, such as number of discussion messages posted, number of messages sent and number of assessments completed, along with EDM and LA techniques, can be a more powerful tool in helping teachers assessing their students' activities and predicting their academic performance. Similarly, Wolff et al. (2013) found that a combination of LMS data and data coming from ongoing formative assessments were the best predictor for performance of 7701 higher education students. However, not all LMS data sources are important for formative assessment and learning evaluation in general. For example, tracking simple clicking user's behaviour or using an LMS track data does not help predicting students' performance (MacFayden & Dawson, 2010; Tempelaar, Rienties & Giesbers, 2015). Thus, it is important to choose the kind of EDM/LA that can actually have an added value in the formative assessment process.

- *Social Networking Analysis and Detecting undesirable student behaviours*

With the exposure of students to Social Network tools, a number of studies researched the possibilities Social Networks Analysis (SNA) tools developed specifically for educational purposes. For example, early work of Reffay and Chanier (2002) indicated that the use of SNA could help teachers monitor their students' collaborative activities within a Social Network. Similarly, Dawson, Bakharia and Heathcote (2010) developed the Social Networks Adaptive Pedagogical Practice (SNAPP) tool in order to extract data from students' online activities and present such data in a an easy-to-interpret way so as to assist teachers to use such data easily and fast, providing timely feedback and scaffolding for students who seem to have troubles as indicated by the tool. SNAPP can be used within existing LMS/VLE and can provide a social graph of the discussions made within the Discussion Forums providing visualizations of the social interaction of students (See Figure 12). This can help teachers identify the peer interaction in their classroom as well as the students who are not participating or have low interaction with peers and, thus make informed and targeted decisions so as to boost students' interaction and discussions (Dawson, Bakharia & Heathcote, 2010; Dawson & McWilliam, 2008).

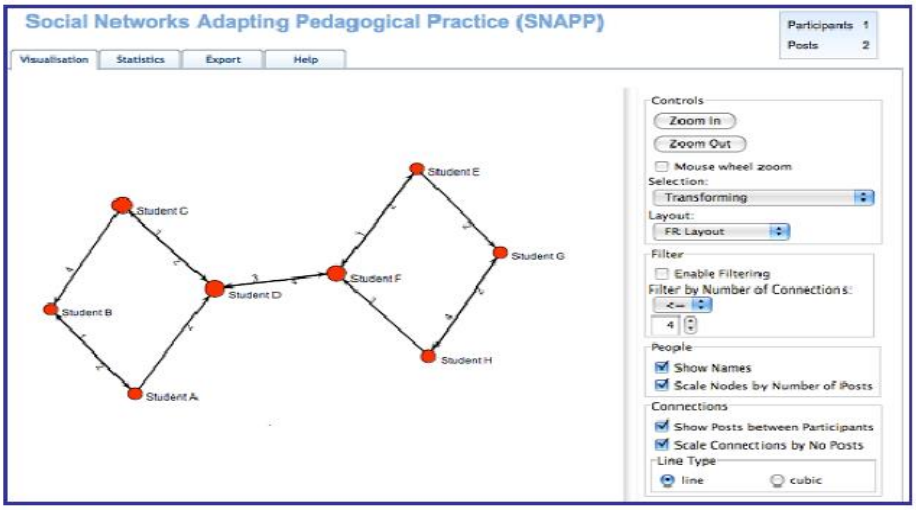

FIGURE 12: SNAPP'S INTERFACE (DAWSON, BAKHARIA & HEATHCOTE, 2010, P.129)

Using most of the applications/techniques that were discussed above can be very helpful for teachers to evaluate the learning process and adapt their teaching accordingly (Zaïane & Luo, 2001). However, most EDM/LA tools are designed to be used by experts (i.e. administrators) and can be quite complex to use as they require teachers to be skilled in analyzing statistics and configuring their settings (Romero & Ventura, 2007) and this can affect teachers' adaptation of such tools in their classrooms. For this reason, researchers and developers focused on creating EDM/LA tools that can be integrated within an existing LMS/VLE or other learning platform, such as SNAPPS described above, Learning Object Context Ontology (LOCO) –Analyst tool, developed by Ali, Hatala, Gasevic et al. (2012) and Learning Analytics Enriched Rubric (LAe-R) plug-in for Moodle LMS platform specifically (Demopoulos, Petropoulou, Boloudakis & Retalis, 2013).

More recently, another LA tool, named ALAS-KA, was developed as an extension module with useful visualizations for the LA tool in order to provide a better understanding the learning process in Khan Academy platform (Valiente, Muñoz-Merino, Leony & Delgado Kloos, 2015). Their investigation of 564 student data samples indicated that teachers were able to collect visualizations of the users' activities including: overall classroom data of students' online activities, students' individual report of activities, comparison between students' activities with the mean of the classroom and other visualization charts (see Figure 13).

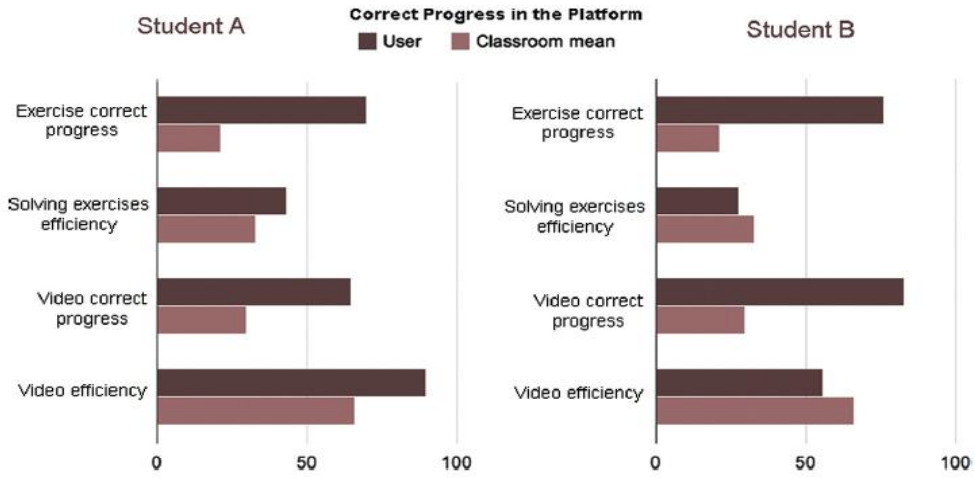

FIGURE 13 VISUALIZATION OF INDIVIDUAL STUDENTS ACTIVITIES IN COMPARISON TO THE CLASSROOM'S MEAN (VALIENTE, MUÑOZ-MERINO, LEONY & DELGADO KLOOS, 2015, P.146).

As it can be seen from the examples above, the application of EDM/LA techniques in web-based learning environments, can enhance teachers' formative assessment lenses as they can provide them with feedback of new and hidden information, help them track their students' activities using visualization charts, graphs and statistics, allowing them to collect evidence and adapt their teaching and/or the learning environment accordingly (Romero & Ventura, 2010; Baker & Siemens, 2014). Nonetheless, EDM applications can be beneficial for students as well, as they provide them with information about their activities, enhancing their self-assessment and as discussed above, in some case, they can provide them with recommendations regarding learning resources and learning pathways accustomed to their learning needs, assisting their self-regulation that way. Such visualizations and especially the individual students' in ALAS-KA tool for example, can be helpful for both teachers' elicitation of data regarding each student's activities but also for the students themselves in respect to their self-assessment and comparison of how they are doing in respect to the classroom's mean.

Nonetheless, EDM and LA have some challenges when it comes to their implementation for educational purposes. Apart from the difficulty of using some of their applications and tools (Romero & Ventura, 2007) teachers, students, parents and community in general are reluctant in using them, because of ethical concerns such as users' informed consent, privacy, classification and management of data and anonymity (Slade & Prinsloo, 2013). Therefore, there are several issues that need to be resolved in order for EDM/LA tools to be fully integrated for educational purposes.

3.3. Summary

Part 3 of this deliverable reviewed a number of technology and tools that have been discussed in evidence-based literature research showing that they can support formative assessment and feedback. In respect to the theoretical framework of good formative assessment and effective feedback provided in Part 2, those tools and technologies can serve multiple purposes in education and some of them can be found in various formats either paper-based or computer/web-based. The Table 2 below provides an overview of the tools and technologies discussed in this Part, in respect to the five strategies of effective formative assessment provided by Wiliam and Thomson (2007) presented in Part 2. Even though it is acknowledged that there are numerous ways of categorizing and classifying such tools and technologies (T&T), this framework is preferred because it provides a holistic encapsulation of most actors and materials that are involved in education. In addition, the Table 2 below is only indicative and was not developed using specific research methodology. It is only created to provide an indicative overview of the literature discussed in Part 3.

As it was discussed in this section, the use of rubrics and scripts can help teachers to share assessment criteria with their students and also help students' understand what is expected from them to do in a task. In addition, rubrics and scripts can enhance self-assessment and peer-assessment processes. Blogs can be used to enhance students' reflective skills and self-regulation both in formal and informal settings. Their online format can also help teachers who keep a blog on their own share their learning intentions with the students and others and at the same time, access their students' blogs so as to elicit evidence of their understandings and provide feedback to what their students are sharing. Wikis can be used as a collaborative tool that provides the opportunity for teachers to track down each student's contribution to the learning task and at the same time

can help students revise their and their peers' input after assessing what they read. Similarly, concept maps apart from their individual use by each student, making student's understandings of a concept visible to others, they can be used and shared collaboratively with the use of web-based tools that can support such features. A more complex approach for enhancing student's self-regulation is the implementation of ePortfolios. In fact, with the use of specific online platforms or set of online tools as discussed above, students can not only share their accomplishments, they can also become the owners of their own learning, especially when teachers take the role of a facilitator during such process.

In addition, the advancements in mobile devices allow teachers to use classroom response systems that can help them elicit evidence of their students' understandings and if the responses are shared with their students, help their students assessing their own progress, receiving immediate feedback regarding their understandings in relation to the rest of the classroom. Computer-based assessment and online testing tools also offer opportunities for students receiving immediate and sometimes enhanced feedback and at the same time can help teachers archive students' responses and monitor their progress over time. The use of technology-enhanced learning environments, apart from their function of helping teachers share content and material with their students, they can facilitate online discussions and other learning tasks that can help the teacher monitor their students' activities. Additionally, if enabled, teachers can review a range of learning analytics' tools within the TELEs so as to collect valuable quantitative and qualitative data of their students' understandings and activities within such learning environments. Indeed, the use of educational data mining techniques and learning analytics provides teachers with new lenses of looking at their students' learning activities and behaviours. However, the use of such collection of evidence is often challenged as there are several ethical issues to consider. Nonetheless, they provide a valuable insight on students' understandings.

FA strategies / T&T	1. Clarifying (understanding) and sharing learning intentions and criteria for success	2. Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding	3. Providing feedback that moves learners forward	4. Activating students as instructional resources for one another	5. Activating students as the owners of their own learning
Rubrics	●	●	●	●	●
Scripts	●	○	●	●	●
Blogs	○	●	○	●	●
Wikis	●	●	○	●	●
Concept Maps	●	●	○	○	●
ePortfolios	●	●	●	●	●
Computer-based Assessment	○	●	●	○	○
Classroom Response Systems	○	●	●	●	●
Technology-Enhanced Learning Environments	●	●	●	●	○
Learning Analytics and Educational Data Mining	–	●	●	○	●

TABLE 2 TOOLS AND TECHNOLOGIES FOR SUPPORTING FORMATIVE ASSESSMENT PROCESS

● **Highly supported by evidence-based research literature**

○ **Supported by evidence-based literature under specific conditions**

_ **Not supported by evidence-based literature**

4. Conclusion - Implications

The ongoing development of technologies continuously offers advancements and new opportunities for the use of tools that can be used for educational purposes. This deliverable discussed literature related to formative assessment and feedback processes in education and provided an overview of certain tools and technologies that are found in literature as supporting such processes. As it was concluded in Part 3, rubrics, scripts, wikis, blogs, concept maps, ePortfolios, computer-based assessment and (online) testing, classroom response systems, technology-enhanced learning environments, educational data mining and learning analytics can help both teachers and students in closing the 'gap' between where students are and where students need to be.

Despite the fact that research in the field of formative assessment argues that such processes positively impact students' academic performance, there are a number of meta-analyses that challenge this argument stating that the research reported so far fail to provide sufficient evidence. For example, Kingston and Nash (2011, abstract) review of more than 300 studies of formative assessment effectiveness argued that: "*Many of the studies had severely flawed research designs yielding uninterpretable results. Only 13 of the studies provided sufficient information to calculate relevant effect sizes".* This was similar to Dunn and Mulvenon (2009, p.1) who challenged the validity of Black and Wiliam's (1998a) report as the studies used, revealed *"limited empirical evidence"* of formative assessment effectiveness in respect to students' learning. Such claims show the need for better research designs in investigating the effectiveness of formative assessment processes and tools within a classroom, in respect to students' learning achievements and skills development. As it was shown in Part 3, the use of technologies that have the affordances of recording massive data of students' activities and behaviours both within a traditional classroom and in a virtual learning environment can be employed in order to help both teachers and researchers collect such empirical evidence (Smith, 2007; Grob, Bensberg & Kaderali, 2004; Romero & Ventura, 2010). Indeed in several of the research discussed in Part 3, it has been argued that much of the data collected with the use of technology (i.e. in TELE tools) can also be used by stakeholders, school leaders and researchers so as to improve the way an educational system works (Fitch et al., 2008; Grob, Bensberg & Kaderali, 2004).

The review of the related-literature revealed numerous and different tools and technologies being developed by several researchers and developers so as to support formative assessment, indicating the volume of the advancements in the field. However, most of those tools and technologies require several students' and teachers' accounts so as to be used. Research argues that both teachers and students' perceived ease of use of a technological tool is an important factor for using it in the long term (Terzis & Economides, 2011). So far, there have been several attempts of combining and merging existing tools and technologies (i.e. integrating Mahara ePortfolio platform with Moodle VLE platform – Mahoodle) and several discussions of the potentials of such integrations in order to provide a richer learning environment (i.e. Queirós, Oliveira, Leal & Moreira, 2011). Thus, it seems that the development of a new or integrations in existing technology-enhanced learning environments so as to provide teachers and students with the tools and technologies (for example

the ones illustrated in Table 2 above) to support formative assessment process and feedback in one place might be important.

However, the use of technology and tools for supporting teachers and students in formative assessment process require that both teachers and students redefine their roles in the learning process and also develop skills so as to be able to use them effectively (Romero & Ventura, 2010; Ali, Asad, Gasevic et al., 2013). Analyzing and interpreting, for example, massive data of students' behaviour in an online platform is a process that not all teachers can easily perform, as it requires certain skills (Ali, Asad, Gasevic et al., 2013). In addition, the effective use of feedback requires both teachers and students to be able to share an understanding of the information being shared and at the same time requires students to be able to act upon such information using higher order skills, such as reflective and meta-cognitive skills (Sadler, 1989; Havnes et al., 2012). Thus, the tools and technologies themselves do not lead to the effective use of formative assessment processes in an educational context. Rather, it is required that both teachers and students (and sometimes the entire school community) need to be able to use such tools and technologies effectively. Therefore, extensive trainings of both teachers and students are essential. As Yorke (2003) suggests, perhaps it is important focusing on ways for developing students' evaluation skills as much as focusing on enhancing teachers' ability to provide feedback, because students are always involved in assessing and monitoring their work.

References

[Untitled illustration of computer response system devices]. Retrieved October 10, 2015 from http://smarttech.com/~/media/84B4BB1DD1F74EF5BD296CC7181A9894.ashx?sc_lang=en.

1st International Conference of Learning Analytics and Knowledge (2011). Retrieved from: https://tekri.athabascau.ca/analytics/

Abrahamson L.A. (2006). A brief history of networked classrooms: effects, cases, pedagogy, and implications. *In* D.A., Banks (ed) *Audience response systems in higher education: applications and cases*. (pp. 1-25). Hershey: Idea Group Inc.

Abrami, C. Ph, & Barrett, H. (2005). Directions for research and development on electronic portfolios. *Canadian Journal of Learning and Technology, 31*(3). Available online at: http://cjlt.csj.ualberta.ca/index.php/cjlt/article/view/92/86

Agrawal, R., & Srikant, R. (1995). Mining sequential patterns. *In Eleventh international conference on data engineering* (pp. 3–14). Taipei, Taiwan: IEEE Computer Society Press.

Agrawal, R., Imielinski, T., & Swami, A. (1993). Mining association rules between sets of items in large databases. *In Proceedings of the 1993 ACM SIGMOD international conference on management of data, Washington, DC* (pp. 207–216).

Agudo-Peregrina, A.F., Iglesias-Pradas, S., Conde-González, M.A. & Hernández-García, A. (2014). Can we predict success from log data in VLEs? Classification of interactions for learning analytics and their relation with performance in VLE-supported F2F and online learning. *Computers in Human Behaviour, 31*, 542-550.

Aleven, V., Stahl, E., Schworm, S., Fischer, F., & Wallace, R. M. (2003). Help seeking and help design in interactive learning environments. *Review of Educational Research, 73*(2), 277-320

Ali, L., Asadi, M., Gasevic, D., Jovanovic, J. & Hatala, M. (2013). Factors influencing beliefs for adoption of a learning analytics tool: An empirical study. *Computers & Education, 62*, 130-148.

Ali, L., Hatala, M., Gašević, D., & Jovanović, J. (2012 (January)). A qualitative evaluation of evolution of a learning analytics tool. Computers & Education, 58(1), 470–489.

Alonso-Tapia, J., & Panadero, E. (2010). Effects of self-assessment scripts on self-regulation and learning. *Infancia y Aprendizaje, 33*(3), 385-397

Andrade, H. & Valtcheva, A. (2009). Promoting learning and achievement through self-assessment. *Theory into Practice, 48*(1), 12-19

Andrade, H. (1999, April). *The role of instructional rubrics and self-assessment in learning to write: A smorgasbord of findings*. Paper presented at the Annual Meeting of the American Educational Research Association, Montreal, Canada.

Andrade, H., & Du, Y. (2005). Student perspectives on rubric-referenced assessment. *Practical Assessment, Research & Evaluation, 10*(3), 1–11.

Apostolopoulou, D., Panagiotakopoulos, C., & Karatrantou, A. (2014). Theories of learning in math and science educational software (pp. 25-39). C. Karagiannidis, P. Politis and I. Karasavvidis (eds.) *Research on e-learning and ICT in education: Technological, Pedagogical and Instructional Perspectives*. NY: Springer

Ashwell, T. (2000). Patterns of teacher response to student writing in a multiple-draft composition classroom: Is content feedback followed by form feedback the best method? *Journal of Second Language Writing, 9*(3), 227-257.

Assessment Reform Group (2002). *Assessment for Learning: 10 Principles*. Cambridge: University of Cambridge School of Education.

Avouris, N., Komis, V., Fiotakis, G., Margaritis, M. & Voyiatzaki, E. (2005). Why logging of fingertip actions is not enough for analysis of learning activities, In *Proc. AIED Conf. Workshop Usage Anal. Learn. Syst., Amsterdam, The Netherlands,* (pp. 1–8).

Baker, R. & Siemens, G. (2014) Educational data mining and learning analytics. *In* K., Sawyer, (Ed.) *Cambridge Handbook of the Learning Sciences: 2nd Edition*, (pp. 253-274). NY: Cambridge University Press.

Baker, R.S.J.d., Corbett, A.T., Koedinger, K.R., Evenson, S.E., Roll, I., Wagner, A.Z., Naim, M., Raspat, J., Baker, D.J., Beck, J. (2006). Adapting to When Students Game an Intelligent Tutoring System. *Proceedings of the 8th International Conference on Intelligent Tutoring Systems*, pp. 392-401.

Balan, A. (2012). Assessment for learning: A case study in mathematics education. Doctoral dissertation. Malmö University, Malmö, Sweden.

Bangert-Drowns, R. L., Kulik, C. L., Kulik, J. A., & Morgan, M. T. (1991). The instructional effect of feedback in test-like events. *Review of Educational Research, 61*,213–237.

Bannert, M. (2009). Promoting self-regulated learning through prompts. *Zeitschrift Fur Padagogische Psychologie, 23*(2), 139–145

Barbera, E. (2009). Mutual feedback in e-portfolio assessment: an approach to the netfolio system. *British Journal of Educational Technology, 40*(2), 342–357.

Barrett, H. (2003, October). *The eportfolio: A revolutionary tool for education and training?* Paper presented at the first International Conference on the e-Portfolio, Poiters, France. Retrieved October 10, 2015, from http://electronicportfolios.org/portfolios/eifel.pdf

Barrett, H. C. (2011). Balancing the two faces of e-portfolios. *In* S. Hirtz and K. Kelly. *Education for a Digital World: Advice, Guidelines, and Effective Practice from Around the Globe (2nd.).* Province of British Columbia.

Barrett, H.C. (2007). Researching electronic portfolios and learner engagement: the REFLECT initiative. *Journal of Adolescent & Adult Literacy. 50*(6), 436-449.

Barzel, B., Drijvers, P., Maschietto, M., & Trouche, L. (2005). *Tools and technologies in mathematical didactics*. Proceedings of the Fourth Congress of the European Society for Research in Mathematics Education (pp. 927–938), Saint Feliu de Guixols, Spain.

Baturay, M.H. & Daloglu, A. (2010). E-portfolio assessment in an online English language course. *Computer Assisted Language Learning, 23*(5), 413-428.

Beatty, I, D. & Gerace, W, J. (2009), Technology-enhanced formative assessment: A research-based pedagogy for teaching science with classroom response technology. *Journal of Science Education and Technology, 18*(2) 146-162.

Beatty, I. D. (2004). Transforming student learning with classroom communication systems. *Research Bulletin ERB0403*, *Educause Center for Applied Research*. Retrieved from: https://net.educause.edu/ir/library/pdf/ERB0403.pdf. Last accessed: 14 October 2015.

Bell, B. & Cowie, B. (1997). Formative assessment and science education: Research report of the Learning in Science Project (Assessment), Hamilton, NZ: University of Waikato.

Bell, B., & Cowie, B. (2001). The characteristics of formative assessment in science education. *Science Education, 85*(5), 536-553

Bermingham, V., & Hodgson, J. (2006) Feedback on Assessment: Can we provide a better student experience by working smarter than by working harder? *The Law Teacher*, 42(2), 151-172

Bhalero, A. & Ward, A. (2001). Towards electronically assisted peer assessment: a case study. *Association for Learning Technology Journal, 9*(1) 26-37.

Bienkowski, M., Feng, M., & Means, B. (2012). *Enhancing teaching and learning through educational data mining and learning analytics*. Washington, DC: U.S. Department of Education. Retrieved from http://www.ed.gov/edblogs/technology/files/2012/03/edm-la-brief.pdf

Black, P., & Wiliam, D. (1998a). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, *5(*1), 7-74.

Black, P., & Wiliam, D. (1998b). Inside the black box: Raising standards through classroom assessment. *Phi Delta Kappan, 80*, 139-148.

Black, P., & Wiliam, D. (2006). Developing a theory of formative assessment. *In* J.Gardner (Ed.), *Assessment and learning* (pp. 81–100). London: Sage.

Black, P., Harrison, C., Lee, C., Marshall, B., & Wiliam, D. (2003). *Assessment for learning: Putting it into practice.* Maidenhead: Open University Press.

Boud, D. (2001). Using journal writing to enhace reflective practice. *New Directions for Adult and Continuing Education, 20*, 9–17.

Boyle, J.T., & Nicol, D.J. (2003). Using classroom communication systems to support interaction and discussion in large class settings. *Association for Learning Technology Journal 11*,(3), 43–57.

Bransford, J. D., Brown A. L. & Cocking, R.R. (eds.) (2000). *How People Learn*. Washington, D.C.,: National Academy Press.

Brown, G. T. L., Glasswell, K., & Harland, D. (2004). Accuracy in the scoring of writing: Studies of reliability and validity using a New Zealand writing assessment system. *Assessing Writing, 9*(2), 105–121

Buchanan, T. (2000). The efficacy of a World-Wide Web mediated formative assessment. *Journal of Computer Assisted Learning, 16,* 193-200.

Buckley, S., Coleman, J., & Khan, K. (2010). Best evidence on the educational effects of undergraduate portfolios. *Clinical Teacher, 7*(3), 187–191

Buldu, M. & Buldu, N. (2010) Concept mapping as a formative assessment in college classrooms: Measuring usefulness and student satisfaction. *Procedia Social and Behavioural Sciences, 2*, 2099–2104

Burnstein, R.A. & Lederman, L.M. (2003). Comparison of different commercial wireless keypad systems. *The Physics Teacher, 41*(5), 272-275.

Butler, P., Anderson, B., Brown, M., Simpson, M., Higgins, A., Northover, M., Meyer, L., Connor, M., Lamont, M. & Wyles, R. (2006). *A review of the literature on portfolios and electronic portfolios*. Available online: http://akoaotearoa.ac.nz/download/ng/file/group-996/n2620-eportfolio-research-report.pdf

Caldwell, J. E. (2007). Clickers in the Large Classroom: Current Research and Best-Practice Tips. *CBE—Life Sciences Education, 6*(1), 9–20

Campbell, & Oblinger, D. (2007). Academic analytics. Washington, DC: EDUCAUSE Center for Applied Research. Retrieved from: https://net.educause.edu/ir/library/pdf/PUB6101.pdf. Last accessed: October 10, 2015.

Cañas AJ, Carvalho M, Arguedas M, Leake DB, Maguitman A, & Reichherzer T. (2004). Mining the web to suggest concepts during concept map construction. *In*: Cañas AJ, Novak JD and Gonzàlez FM (Eds). *Concept Maps: Theory, Methodology, Technology*. Proceedings of the 1st International Conference on Concept Mapping. (pp. 135–142). Universidad Pùblica de Navarra: Pamplona

Carless, D. (2005). Prospects for the implementation of assessment for learning. *Assessment in Education: Principles, Policy & Practice, 12*(1), 39-54.

Carneiro, R., Lefrere, P., Steffens, K. & Underwood, J. (2011) (Eds.). *Self-regulated Learning in Technology Enhanced Learning Environments: A European Perspective*. Rotterdam: Sense Publishers.

Carneiro, R., Lefrere, P., Steffens, K. & Underwood, J. (Eds.) (2011). *Self-regulated Learning in Technology Enhanced Learning Environments: A European Perspective.* Technology Enhanced Learning, Vol. 5. Rotterdam: Sense Publishers.

Chang Barker, K. (2006). Foreword. *In* A. Jafari & C. Kaufman (Eds.), *Handbook of Research on eportfolios* (pp. 26-28). Hershey, USA: Idea Group.

Chang, Y. J., Wu, C. T., & Ku, H. Y. (2005). The introduction of electronic portfolios to teach and assess English as a foreign language in Taiwan. *TechTrends: Linking Research & Practice to Improve Learning, 49*(1), 30–35.

Chappuis, J. (2009). *Seven Strategies of Assessment for Learning*. Hawker Brownlow Education Pty Ltd

Charlesworth, M. (2012). *Promoting the use of classroom response systems, Learning with mobile technologies, handheld devices and smart phones: Innovative methods*. Huddersfield, UK: The University of Huddersfield.

Chatham-Carpenter, A., Seawel, L., & Raschig, J. (2009). Avoiding the pitfalls: Current practices and recommendations for ePortfolios in higher education. *Journal of Educational Technology Systems, 38*(4), 437–456.

Cheng, G., & Chau, J. (2011). A comparative study of using blogs and wikis for collaborative knowledge construction. *International Journal of Instructional Media, 38*(1), 71-78.

Cheng, G., & Chau, J. (2013). Exploring the relationship between students' self-regulated learning ability and their ePortfolio achievement. *The Internet and Higher Education*, *17*, 9-15

Chesney, T. & Su, D.K.S. (2010). The impact of anonymity on weblog credibility. *International Journal of Human-Computer Studies, 68(*10), 710-718.

Clark, I. (2011). Formative assessment: Policy, perspectives and practice. *Florida Journal of Educational Administration & Policy, 4*(2), 158–180.

Council of Chief State School Officers (CCSSO). (2008). *Attributes of effective formative assessment*. Washington, DC: CCSSO FAST-SCASS

Cowie, B. (2005). Pupil commentary on assessment for learning. *Curriculum Journal, 16*(2), 137 - 151.

Cowie, B., & Bell, B. (1999). A Model of Formative Assessment in Science Education. *Assessment in Education: Principles, Policy & Practice, 6*(1), 101-116.

Credé, M., & Niehorster, S. (2012). Adjustment to College as Measured by the Student Adaptation to College Questionnaire: A Quantitative Review of its Structure and Relationships with Correlates and Consequences. *Educational Psychology Review, 24(*1), 133-165.

Crisp, B. (2007). Is it worth the effort? How feedback influences students' subsequent submissions of assessable work. *Assessment & Evaluation in Higher Education, 32*, 571–81.

Crooks, T. J. (2002). Educational assessment in New Zealand schools. *Assessment in Education: Principles, Policy & Practice, 9*(2), 237-253.

Dawson, S., & McWilliam, E. (2008). *Investigating the application of IT generated data as an indicator of learning and teaching performance.* Canberra: Australian Learning and Teaching Council.

Dawson, S., Bakharia, A., & Heathcote, E. (2010). SNAPP: Realising the affordances of real-time SNA within networked learning environments. *Proceedings of the 7th International Conference on Networked Learning 2010* (pp. 125-133), Denmark.

DeBarger, A. H., Penuel, W., Harris, C., & Schank, P. (2010). Teaching routines to enhance collaboration using classroom network technology. *In* F. Pozzi & D. Persico (Eds.), *Techniques for fostering collaboration in online learning communities: Theoretical and practical perspectives* (pp. 224-244). Hershey, PA. IGI Global.

Deng, L. & Yuen, A.H.K. (2011). Towards a framework for educational affordances of blogs. *Computers & Education 56(*2), 441-451

DeSchryver, M., Mishra, P., Koehler, M. & Francis, A. (2009). Moodle vs. Facebook: does using Facebook for discussions in an online course enhance perceived social presence and student interaction? *In* I. Gibson et al. (Ed.), *Proceedings of society for information technology & teacher education international conference* (pp. 329–336). Chesapeake, VA: Association for the Advancement of Computing in Education (AACE).

Dimopoulos, I., Petropoulou, O., Boloudakis, M., & Retalis, S. (2013). Using learning analytics in Moodle for assessing students' performance. *In 2nd Moodle Research Conference*.

Dixon, H. R. (2011). Infusing peer assessment into classroom programmes: Descriptions of practice. *SET: Research Information for Teachers, 2,* 3-10.

Dochy, F., Segers, M., & Sluijsmans, D. (1999). The use of self-, peer- and co-assessment in higher education. A review. *Studies in Higher Education, 24*(3), 331–350.

Dringus, L., & Ellis, T. (2005). Using data mining as a strategy for assessing asynchronous discussion forums. *Computer & Education, 45*, 141–160.

Dufresne R.J., Gerace W.J., Leonard W.J., Mestre J.P. & Wenk L. (1996). Classtalk: a classroom communication system for active learning. *Journal of Computing in Higher Education, 7*(2), 3–47.

Dufresne R.J., Gerace W.J., Mestre J.P. & Leonard W.J. (2000). ASK-IT/ A2L: assessing student knowledge with instructional technology (Tech. Rep. dufresne-2000ask). University of Massachusetts Amherst Scientific Reasoning Research Institute.

Dunn, K. E., & Mulvenon, S. W. (2009). A critical review of research on formative assessments: The limited scientific evidence of the impact of formative assessments in education. *Practical Assessment & Research and Evaluation, 14*(7), 1-11.

Ebersbach, A., Glaser, M., & Heigl, R. (2006). *Wiki: Web collaboration.* Berlin, Heidelberg: Springer-Verlag

Efklides, A. (2011). Interactions of metacognition with motivation and affect in self-regulated learning: The MASRL model. *Educational Psychologist, 46*(1), 6-25.

Ehley, L. (2006). Digital portfolios: A study of undergraduate student and faculty use and perceptions of Alverno College's Diagnostic Digital Portfolio. Ed.D Dissertation, Cardinal Stritch University, Wisconsin.

Elgort, I., Smith, A. G., & Toland, J. (2008). Is wiki an effective platform for group course work? *Australian Journal of Educational Technology, 24(*2), 195–210.

EUfolio (2015). EU Classrooms ePortfolios: Pilot Evaluation Results. Available online from: https://eufolioresources.files.wordpress.com/2015/03/d17-appendix-d-pilotevaluationresults_final.pdf, Last accessed: October 10, 2015

Fagen, A. P., Crouch, C. H., & Mazur, E. (2002). Peer instruction: Results from a range of classrooms. *The Physics Teacher, 40*(4), 206-207.

Fies, C., & Marshall, J. (2006). Classroom response systems: A review of the literature. *Journal of Science Education and Technology, 15*(1), 101–109.

Fitch, D., Peet, M., Glover Reed, B., & Tolman, R. (2008). The use of ePortfolios in evaluating the curriculum and student learning. *Journal of Social Work Education, 44*(3), 37-54

Galal, S.M., Mayberry, J.K., Chan, E., Hargis, J. & Halilovic, J. (2015, in press). Technology vs. pedagogy: Instructional effectiveness and student perceptions of a student response system. *Currents in Pharmacy Teaching and Learning.*

Gardner L., Sheridan D. & White D. (2002) A web-based learning and assessment system to support flexible education. *Journal of Computer Assisted Learning, 18*, 125–136.

Gardner, J. (2006). Assessment and learning: An introduction. *In* J. Gardners (Ed.), *Assessment and learning* (pp. 1-5). London: SAGE Publications.

Gardner, J. (2012). *Assessment and learning* (2nd ed.). London: SAGE.

Garrison, C., & Ehringhaus, M. (2007). Formative and summative assessments in the classroom. Retrieved from http://www.amle.org/Publications/WebExclusive/Assessment/tabid/1120/Default.aspx. Last accessed: October 10, 2015

Gaytan, J. & McEwen, B.C. (2007) Effective online instructional assessment strategies. *The American Journal of Distance Education, 21*(3), 117–132

Gipps, C. (1994). *Beyond testing: Towards a theory of educational assessment*. London: Falmer Press.

Goldstein, P. J. (2005). Academic analytics: The uses of management information and technology in higher education. ECAR Key Findings. Retrieved from http://net.educause.edu/ir/library/pdf/ERS0508/ekf0508.pdf. Last accessed: October 10, 2015.

Goodman, D., & Hambleton, R. (2004). Student test score reports and interpretive guides: Review of current practices and suggestions for future research. *Applied Measurement in Education, 17*(2), 37–41.

Goodyear, P. & Retalis, S., (eds) (2010) *Technology-Enhanced Learning: Design Patterns and Pattern Languages*, Rotterdam: Sense Publishers

Govaerts, S., Verbert, K., Dahrendorf, D., Ullrich, C., Schmidt, M., Werkle, M., & Law, E. (2011). Towards responsive open learning environments: The ROLE interoperability framework. *In* C. Delgado Kloos, D. Gillet, R. M. Crespo García, F. Wild, & M. Wolpers (Eds.), *Proceedings of the 6th European Conference on Technology Enhanced Learning: Towards Ubiquitous Learning, EC TEL'11* (pp. 125-138). Berlin, Germany: Springer Verlag.

Grob, H., Bensberg, F., & Kaderali, F. (2004). Controlling open source intermediaries – a web log mining approach. In *Proceedings of the 26th international conference on information technology interfaces* (pp. 233–242).

Halic, O., Lee, D., Paulus, T., & Spence, M. (2010). To Blog or Not to Blog: Student Perceptions of Blog Effectiveness for Learning in a College-Level Course. *Internet and Higher Education, 13*(4), 206-13

Hamalainen, W., Suhonen, J., Sutinen, E., & Toivonen, H. (2004). Data mining in personalizing distance education courses. *In World conference on open learning and distance education, Hong Kong.*

Handley, K. & Williams, L. (2011). From copying to learning: using exemplars to engage students with assessment criteria and feedback. *Assessment & Evaluation in Higher Education, 36*(1), 95-108

Harlen, W., & James, M. (1997). Assessment and Learning: differences and relationships between formative and summative assessment. *Assessment in Education: Principles, Policy & Practice, 4*(3), 365-379.

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research, 77*(1), 81-112.

Hatzipanagos, S. & Warburton, S. (2009). Feedback as Dialogue: Exploring the Links between Formative Assessment and Social Software in Distance Learning. *Learning, Media and Technology, 34*(1), 45–59.

Havnes, A., Smith, K., Dysthe, O., & Ludvigsen, K. (2012) Formative assessment and feedback: Making learning visible. *Studies in Educational Evaluation, 38*, 21–27

Heafner, T. L., & Friedman, A. M. (2008). Wikis and constructivism in secondary social studies: fostering a deeper understanding. *Computers in the Schools, 35*(3–4), 288–302.

Heritage, M. (2007). Formative assessment: What do teachers need to know and do? *Phi Delta Kappan, 89(2)*, 140-145

Heritage, M. (2010). *Formative Assessment: Making it happen in the classroom*. Thousand Oaks, CA: Corwin Press.

Hounsell, D. (1997) Contrasting conceptions of essay-writing. *In* F. Marton, D. Hounsell and N. Entwistle (Eds) *The Experience of Learning*. Edinburgh: Scottish Academic Press.

Hung, S-T. A. (2012). A washback study on e-portfolio assessment in an English as a Foreign Language teacher preparation program. *Computer Assisted Language Learning, 25*(1), 21-36.

Hwang, G.J, Wu, P.H, & Ke, H.R. (2011). An interactive concept map approach to supporting mobile learning activities for natural science courses. *Computers & Education, 57*(4), 2272-2280.

Irons, A. (2008). *Enhancing Learning through Formative Assessment and Feedback*. London: Routledge

Jafari, A. (2004). The sticky e-portfolio system: tackling challenges and identifying attributes. *Educause Review, 39*(4), 38–49.

Janosik, S. M., & Frank, T. E. (2013). Using ePortfolios to measure student learning in a graduate preparation program in higher education. *International Journal of ePortfolio, 3*(1), 13–20.

JISC (2007). *Effective practice with e-Assessment: An overview of technologies, policies and practice in further and higher education.* Available online at: http://www.jisc.ac.uk/media/documents/themes/elearning/effpr aceassess.pdf

Johannesen, M. (2013). The role of virtual learning environments in a primary school context: An analysis of inscription of assessment practices. *British Journal of Educational Technology, 44*(2), 302-313.

Jones, N., Blackey, H., Fitzgibbon, K. & Chew, E. (2010). Get out of MySpace. *Computers & Education, 54*(3), 776–882.

Jonsson, A. (2008). Educative assessment for/of teacher competency. Doctoral dissertation. Malmö University, Malmö, Sweden

Jonsson, A., & Svingby, G. (2007). The use of scoring rubrics: Reliability, validity and educational consequences. *Educational Research Review, 2*(2), 130–144.

Juwah, C. Macfarlane-Dick, D., Matthew, B., Nicol, D., Ross, D., & Smith, B. (2004). *Enhancing Student Learning Through Effective Student Feedback.* The Higher Education Academy (Generic Centre).

Retrieved from: http://www.heacademy.ac.uk/resources/detail/id353_effective_formative_feedback_juwah_etal. Last accessed: October 10, 2015

Kahl, S. (2005). Where in the world are formative tests? Right under your nose! *Education Week, 25*(9), p. 38.

Kao, G. Y. M., Lin, S. S. J., & Sun, C. T. (2008). Breaking concept boundaries to enhance creative potential: using integrated concept maps for conceptual self-awareness. *Computers & Education, 51*(4*)*, 1718–1728.

Kelly, J. (2009). Parsing the online ecosystem: Journalism, media, and the blogosphere. *The economics of Information, Communication and Entertainment, 2*, 93–108

Keppell, M., Au, E., Ma, A. & Chan, C. (2006). Peer learning and learning-oriented assessment in technology-enhanced environments, *Assessment & Evaluation in Higher Education, 31*(4), 453-464.

Kerawalla, L., Minocha, S., Kirkup, G., & Conole, G. (2009). An empirically grounded framework to guide blogging in higher education. *Journal of Computer Assisted Learning, 25*(1), 31-42

Khan K.S., Davies D.A. & Gupta J.K. (2001) Formative self-assessment using multiple true-false questions on the Internet: feedback according to confidence about correct knowledge. *Medical Teacher, 23*, 158–163.

Kingston, N. & Nash, B. (2011). Formative Assessment: A meta-analysis and a call for research. *Educational Measurement: Issues and Practice, 30*(4), 28–37.

Klenowski, V. (2002). *Developing portfolios for learning and assessment. Processes and principles*. London: Routledge Falmer.

Klosgen, W., & Zytkow, J. (2002). *Handbook of data mining and knowledge discovery*. New York: Oxford University Press.

Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychological Bulletin, 119*, 254–284.

Kluger, A. N., & DeNisi, A. (1998). Feedback interventions: Toward the understanding of a double-edged sword. *Current Directions in Psychological Science, 7(*3), 67-72.

Knight, P. (2006). Assessing complex achievements. *In* I. McNay (Ed.), *Beyond mass higher education: Building on experience* (pp.96-104). Maidenhead, UK: The Society for Research in Higher Education and the Open University Press.

Kostons, D., van Gog, T. & Paas, F. (2011). Training self-assessment and task-selection skills: A cognitive approach to improving self-regulated learning. *Learning and Instruction, 22*(2), 121-132.

Landauer, T.K., Lochbaum, K.E., & Dooley, S. (2009). A new formative assessment technology for reading and writing. *Theory into Practice, 48*, 44-52.

Lazakidou, G. & Retalis, S. (2010). Using computer supported collaborative learning strategies for helping students acquire self-regulated problem-solving skills in mathematics. *Computers & Education, 54*(1), 3–13.

Lea, M. (2001). Computer conferencing and assessment: new ways of writing in higher education. *Studies in Higher Education, 26*(2), 163-181.

Lee, Y.J. (2004). Creating a concept map of your Web searches: A design rationale and Web-enabled application. *The Journal of Computer Assisted Learning, 20*, 103–113.

Leont'ev, A.N. (1978). Activity, consciousness and personality. Englewood Cliffs, New Jersey: Prentice Hall.

Limniou, M. & Smith, M. (2010). Teachers' and students' perspectives on teaching and learning through virtual learning environments. *European Journal of Engineering Education, 35*(6), 645-653.

Liu, C. C., Don, P. H., & Tsai, C. M. (2005). Assessment based on linkage patterns in concept maps. *Journal of Information Science and Engineering, 21*(5), 873–890.

Lonn, S. & Teasley, S. D. (2009). Saving time or innovating practice: investigating perceptions and uses of with integration from a physical education perspective. *In* J. Wright, D. Macdonald & L. Burrows (Eds.), *Critical Inquiry and Problem Solving in Physical Education* (pp. 120-132). London: Routledge.

Macfayden, L.P Learning Management Systems. *Computers & Education, 53*(3), 686–694.

Macdonald, D. (2004). Rich tasks, rich learning? Working. & Dawson, S. (2010) Mining LMS data to develop an ''early warning system" for educators: A proof of concept. *Computers & Education, 54*, 588-599.

Mahara (2016). Retrieved from: https://mahara.org

Mak, B., & Coniam, D. (2008). Using wikis to enhance and develop writing skills among secondary school students in Hong Kong. *System, 36*(3), 437–455.

Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., & Byers, A. H. (2011). Big data: The next frontier for innovation, competition, and productivity. McKinsey Global Institute. Retrieved from http://www.mckinsey.com/insights/mgi/research/technology_and_innovation/big_data_the_next_frontier_for_innovation. Last accessed: October 10, 2015.

Markellou, P., Mousourouli, I., Spiros, S., & Tsakalidis, A. (2005). Using semantic web mining technologies for personalized e-learning experiences. *In Proceedings of the web-based education* (pp. 461–826).

Masikunas, G., Panayiotidis, A., & Burke, L. (2007). The Use of Electronic Voting Systems in Lectures within Business and Marketing: A Case Study of their Impact on Student Learning. *ALT-J, Research in Learning Technology, 15*(1), 3-20.

Mazur, E. (1997). *Peer Instruction: A user's manual*. Englewood Cliffs, NJ: Prentice Hall.

Mazza, R., & Milani, C. (2005). Exploring usage analysis in learning systems: Gaining insights from visualisations. *In Workshop on usage analysis in learning systems at 12th international conference on artificial intelligence in education.*

McCormick, M. J., Dooley, K. E., Lindner, J. R., & Cummins, R. L. (2007). Perceived growth versus actual growth in executive leadership competencies: An application of the stair-step behaviourally anchored evaluation approach. *Journal of Agricultural Education, 48*(2), 23–35.

McFarlane, A. (2001), Perspectives on the relationships between ICT and assessment. *Journal of Computer Assisted Learning, 17*, 227–234.

McLaren, S.V. (2012). Assessment is for learning: Supporting Feedback. *International Journal of Technology and Design Education,* 22(2), 227-245.

Meinecke, A. L., Smith, K., & Lehmann-Willenbrock, N. (2013). Developing students as global learners: "Groups in Our World" blog. *Small Group Research, 44*, 428-445.

Mullen, Y. K. (2003). Student improvement in middle school science. Master's thesis, University of Wisconsin

Nardi, B. A., Schiano, D. J., & Gumbrecht, M. (2004). Blogging as social activity, or, would you let 900 million people read your diary? In *Proceedings of the 2004 ACM Conference on Computer Supported Cooperative Work.* (pp. 222–231) *ACM, New York, NY, USA*

Nelson, B. C. (2007). Exploring the use of individual, reflective guidance in an educational multi-user virtual environment. *Journal of Science Education and Technology, 16*(1), 83-97.

Ng, E. M. W., & Lai, Y. C. (2012). An exploratory study on using wiki to foster student teachers' learner-centered learning and self and peer assessment. *Journal of Information Technology Education: Innovations in Practices, 11,* 71–84.

Ng, E.M.W. (2014). Using a mixed research method to evaluate the effectiveness of formative assessment in supporting student teachers' wiki authoring. *Computers & Education, 73*, 141-148.

Nicol, D. (2008). *Transforming Assessment and Feedback: Enhancing Integration and Empowerment in the First Year*. Centre for Academic Practice and Learning Enhancement (CAPLE), University of Strathclyde

Nicol, D. (2009). Assessment for learner self-regulation: enhancing achievement in the first year using learning technologies. *Assessment & Evaluation in Higher Education, 34*(3), 335-352.

Nicol, D. J. & Milligan, C. (2006), Rethinking technology-supported assessment in terms of the seven principles of good feedback practice. *In* C. Bryan and K. Clegg (Eds), *Innovative Assessment in Higher Education*, London: Taylor and Francis Group Ltd

Nicol, D., & MacFarlane-Dick, D. (2004) Rethinking formative assessment in HE: A theoretical model and seven principles of good feedback practice, *in* C. Juwah et al., *Enhancing Student Learning through Effective Formative Feedback*. SENLEF (Student Enhanced Learning through Effective Feedback), the HEA Generic Centre.

Nielsen, K. L., Hansen- Nygård, G., & Stav, J. B. (2012). Investigating peer instruction: How the initial voting session affects students' experiences of group discussion ISRN Education. Available online from: http://www.isrn.com/journals/education/2012/290157/. Last accessed: October 10, 2015.

Novak, J. D. & Cañas, A. J. (2008). *The theory underlying concept maps and how to construct and use them. Technical Report IHMC CmapTools*. Florida: Institute for Human and Machine Cognition.

Novak, J. D. & Gowin, D. B. (1984). *Learning how to learn*. New York, NY: Cambridge University Press.

Novak, J. D., & Cañas, A. J. (2006). The origins of the concept mapping tool and the continuing evolution of the tool. *Information Visualization, 5*(3), 175-184.

Nunes, M. B. & McPherson, M. (2003). Action research in continuing professional distance education. *Journal of Computer Assisted Learning, 19*(4), 429–437.

Olofsson, A. D. , Lindberg, J. O. & Hauge, T. E. (2011). Blogs and the design of reflective peer-to peer technology-enhanced learning and formative assessment. *Campus-Wide Information Systems, 28*(3), 183-194.

Olofsson, A. D. , Lindberg, J. O. & Stödberg, U. (2011). Shared video media and blogging online - educational technologies for enhancing formative e-assessment?. *Campus-Wide Information Systems, 28*(1), 41-55

Pachler, N., Daly, C., Mor, Y., & Mellar, H. (2010). Formative e-assessment: Practitioner cases, *Computers & Education, 54,* 715-721

Palloff, R.M. & Pratt, K. (2005). *Collaborating online: learning together in community*, San Francisco: Jossey-Bass.

Panadero, E. & Alonso-Tapia, J. (2013). Self-assessment: Theoretical and Practical Connotations. When it happens, How is it acquired and what to do to develop it in our students. *Electronic Journal of Research in Educational Psychology, 11*(2), 551-576. Available from: http://dx.doi.org/10.14204/ejrep.30.12200

Panadero, E. & Jonsson, A. (2013) The use of scoring rubrics for formative assessment purposes revisited: A review. *Educational Research Review, 9*, 129-144

Panadero, E., & Jonsson, A. (2013). The use of scoring rubrics for formative assessment purposes revisited: A review. *Educational Research Review, 9*(0), 129–144

Panadero, E., Alonso-Tapia, J., & Huertas, J. A. (2012). Rubrics and self-assessment scripts effects on self-regulation, learning and self-efficacy in secondary education. *Learning and Individual Differences, 22*(6), 806–813

Parker, K. R., & Chao, J. T. (2007). Wiki as a teaching tool. *Interdisciplinary Journal of Knowledge and Learning Objects, 3,* 57–72.

Pedder, D., James, M., & MacBeath, J. (2005). How teachers value and practice professional learning. *Research Papers in Education, 20*(3), 209-243.

Peng, H. Y., Su, Y. J., Chou, C., & Tsai, C. C. (2009). Ubiquitous knowledge construction: mobile learning re-defined and a conceptual framework. *Innovations in Education and Teaching International, 46*(2), 171–183.

Penuel, W. R., Fishman, B. J., Yamaguchi, R., & Gallagher, L. P. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journal, 44*(4), 921-958.

Peters, E. & Kitsantas, A. (2010). The Effect of Nature of Science Metacognitive Prompts on Science Students' Content and Nature of Science Knowledge, Metacognition, and Self Regulatory Efficacy. *School Science and Mathematics*, *110*(8), 382–396

Prins, F. J., Sluijsmans, D. M. A., Kirschner, P. A., & Strijbos, J. W. (2005). Formative peer assessment in a CSCL environment. *Assessment and Evaluation in Higher Education, 30*(4), 417-444.

Pryor, J., & Crossouard, B. (2008). A socio-cultural theorisation of formative assessment. *Oxford Review of Education, 34*(1), 1-20.

Puustinen, M., & Pulkkinen, L. (2001). Models of self-regulated learning: A review. *Scandinavian Journal of Educational Research, 45*(3), 269-286

Queirós, R., Oliveira, L., Leal, J. P., & Moreira, F. (2011). *Integration of ePortfolios in Learning Management Systems*. Paper presented at the International Conference Computational Science and Its Applications - ICCSA 2011, Santander, Spain.

Ramaprasad, A. (1983). On the definition of feedback. *Behavioural Science, 28*(1), 4-13.

Rate, N. (2009). *Portfolio Visualisation*. Retrieved from: http://nickrate.com/2009/12/02/portfolio-visualisation/. Last accessed: October 10, 2015.

Reddy, Y.M. & Andrade, H. (2010). A review of rubric use in higher education. *Assessment and Evaluation In Higher Education, 35I(4)*, 435-448.

Reese, M., & Levy, R. (2009). Assessing the future: E-portfolio trends, uses, and options in higher education. *Research Bulletin, 4*, 1-12

Reffay, C., & Chanier, T. (2002). Social network analysis used for modeling collaboration in distance-learning groups. In S.A. Cerri, G. Guardères, & F. Paraguaçu, (Eds.), *Proceedings of the 6th international conference on intelligent tutoring systems* (pp. 31-40). Biarritz, France.

Reitmeier, C. A., & Vrchota, D. A. (2009). Self-assessment of oral communication presentations in food science and nutrition. *Journal of Food Science Education, 8*(4), 88–92

Ribbens, R. (2007). Why I like clicker personal response systems. *Journal of College Science Teaching, 37*(2), 60-63.

Robertson, J. (2011). The educational affordances of blogs for self-directed learning. *Computers & Education, 57*(2), 1628–1644

Romero, C. & Ventura, S. (2007). Educational data mining: A survey from 1995 to 2005. *Expert Systems with Applications, 33*, 135–146.

Romero, C. & Ventura, S. (2010). Educational data mining: a review of the state of the art. *IEEE Transactions on Systems, Man, And Cybernetics – Part C: Applications and Review, 40*(6), 601-618.

Romero, C., Ventura, S. & Garcia, E. (2008). Data mining in course management systems: Moodle case study and tutorial. *Computers & Education, 51*(1), 368-384.

Ruiz-Primo, M. A., & Furtak, E. M. (2004, April). *Informal assessment of students' understanding of scientific inquiry*. Paper presented at the annual meeting of the American Educational Research Association, San Diego, CA.

Sadler, D. R. (1983). Evaluation and the improvement of academic learning. *Journal of Higher Education, 54*, 60-79.

Sadler, R. D. (1989). Formative assessment and the design of instructional systems. *Instructional Science, 18*(2), 119-144.

Sadler, R. D. (1998). Formative Assessment: revisiting the territory. *Assessment in Education: Principles, Policy & Practice, 5*(1), 77-84

Sadler, R. D. (2010). Beyond feedback: developing student capability in complex appraisal. *Assessment & Evaluation in Higher Education, 35*(5), 535-550.

Schroeder, J., & Greenbowe, T. J. (2009). The chemistry of Facebook: Using social networking to create an online community for the organic chemistry. *Innovate: Journal of Online Education, 5(*4), 9.

Scriven, M. (1967). *The methodology of evaluation*. Washington, DC: American Educational Research Association.

Sheard, M., & Chambers, B. (2011). *Self-paced learning: Effective technology-supported formative assessment. Report on achievement findings*. York, UK: The University of York.

Sheard, M., & Chambers, B. (2014). A case of technology-enhanced formative assessment and achievement in primary grammar: How is quality assurance of formative assessment assured? *Studies in Educational Evaluation, 43*, 14-23.

Shepard, L. A. (2008). Formative assessment: Caveat emptor. *In* C. A. Dwyer (Ed.), *The future of assessment: Shaping teaching and learning* (pp. 279-303). New York: Lawrence Erlbaum Associates.

Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research, 78*, 153–189.

Sidek, E. A. R. & Yunus, M. M. (2012). Students' Experiences on Using Blog as Learning Journals. *Procedia - Social and Behavioural Sciences*, *67*, 135-143

Siemens, G. (2013). Learning Analytics: The Emergence of a Discipline. *American Behavioural Scientist, 57*(10), 1380-1400

Siemens, G., & Baker, R. S. J.d. (2012). Learning analytics and educational data mining: Towards communication and collaboration. In *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge* (pp. 252-254). New York, NY: ACM.

Simelane, S. & Mji, A. (2014). Impact of technology-engagement teaching strategy with the aid of clickers on student's learning style. *Procedia – Social and Behavioural Sciences, 136,* 511-521.

Skiba, D.J. (2006). Got large lecture hall classes? Use clickers. *Nursing Education Perspectives, 27*(5), 278-280.

Slade, S. & Prinsloo, P. (2013). Learning Analytics: Ethical issues and dilemmas. *American Behavioural Scientist, 57*(10) 1510–1529.

Smith, G. (2007). How does student performance on formative assessments relate to learning assessed by exams*? Journal of College Science Teaching. 36* (7), 28-34.

Stiggins, Richard J. (1994). *Student-Centered Classroom Assessment*. New York: Merrill Publishing Co.

Tang, T., & McCalla, G. (2002). Student modeling for a web-based learning environment: A data mining approach. In *Eighteenth national conference on artificial intelligence*, Menlo Park, CA, USA (pp. 967– 968).

Taras, M (2005). Assessment – Summative and Formative – some theoretical reflections, *British Journal of Educational Studies. 53*(3), 466-478

Tempelaar, D. T., Rienties, B. & Giesbers, B. (2015). In search for the most informative data for feedback generation: learning analytics in a data-rich context. *Computers in Human Behaviour*, *47*, 157–167.

Terzis, V. & Economides, A.A. (2011). The acceptance and use of computer based assessment. *Computers & Education, 56*, 1032-1044.

Thillmann, H., Kunsting, J., Wirth, J., & Leutner, D. (2009). Is it merely a question of "What" to prompt or also "When" to prompt? The role of point of presentation time of prompts in self-regulated learning. *Zeitschrift Fur Padagogische Psychologie, 23*(2), 105–115

Topping, K.J., Smith, E.F., Swanson, I., & Elliot, A. (2000). Formative peer assessment of writing between postgraduate students. *Assessment and Evaluation in Higher Education, 25*(2), 149-166.

Torrance, H. & Pryor, J. (1998). *Investigating Formative Assessment: Teaching, Learning and Assessment in the Classroom*. Buckingham: Open University Press).

Tunstall, P., & Gipps, C. (1996). Teacher feedback to young children in formative assessment: A typology. *British Educational Research Journal*, *22*(4), 389–404.

Ueno, M. (2004a). Data mining and text mining technologies for collaborative learning in an ILMS "Samurai". *In* C.-K. Kinshuk, E. Looi, D. G. Sutinen, I. Sampson, L.U. Aedo, & E. Kähkönen (Eds.), *Proceedings of the IEEE International Conference on Advanced Learning Technologies* (pp. 1052-1053). Washington, DC: IEEE Computer Society.

Valiente, J.A., Muñoz-Merino, P., Leony, D. & Delgado Kloos, C. (2015). ALAS-KA: A learning analytics extension for better understanding the learning process in the Khan Academy platform. *Computers in Human Behaviour, 47,* 139-148.

Van der Kleij, F. M. (2013). Computer-based feedback in formative assessment (Unpublished doctoral dissertation). Enschede: University of Twente.

Verbert, K., Duval, E., Klerkx, J., & Govaerts, S. (2013). Learning analytics dashboard applications. *American Behavioural Scientist, 57*(10), 1500–1509

Vogel, D. & Klassen, J. (2001). Technology-supported learning: status, issues and trends. *Journal of Computer Assisted Learning, 17(*2), 104–114.

Vonderwell, S., Liang, X., & Alderman, K. (2007). Asynchronous discussions and assessment in online learning. *Journal of Research on Technology in Education, 39*(3), 309–328

Vygotsky, L. (1978). *Mind in society*. Cambridge, MA: Harvard University Press

Walker, J. M. T. & King, P. H. (2003). Concept mapping as a form of student assessment and instruction in the domain of biomedical engineering. *Journal of Engineering Education, 19*(2), 167-179.

Wang T.H., Wang K.H., Wang W.L. & Huang, S.C. (2004) Assessing effectiveness of formative assessment models on students' learning achievement in e-learning environment. *Chinese Journal of Science Education, 12*, 469–490.

Wang, A. Y., Newlin, M. H., & Tucker, T. L. (2001). A discourse analysis of online classroom chats: Predictors of cyber-student performance. *Teaching of Psychology, 28*, 221–225.

Wang, C. X. & Kinuthia, W. (2004). Defining technology enhanced learning environments for pre-service teachers. *Proceedings of Society for Information Technology and Teacher Education International Conference, 2004* (1), 2724–2727.

Wang, F. & Hannafin, M, J. (2005). Design-based research and technology-enhanced learning environments. *Educational Technology Research and Development, 53*(4), 5-23

Wang, Q. Y., & Woo, H. L. (2008). Affordances and Innovative Uses of Weblogs for Teaching and Learning. *In* Kobayashi, R (Ed.), *New educational technology* (pp. 183-199). NY: Nova Science Publishers

Wang, Q., Woo, H.L., Quek, C.L., Yang, Y. & Liu, M. (2012). Using the Facebook group as a learning management system: An exploratory study. *British Journal of Educational Technology, 43*(3), 428-438.

Wang, T.H. (2007). What strategies are effective for formative assessment in an e-learning environment? *Journal of Computer Assisted Learning, 23*(3), 171–186.

Weller, M. (2011). The Nature of Scholarship. *In* The Digital Scholar: How Technology Is Transforming Scholarly Practice (pp. 41–51). London: Bloomsbury Academic. Retrieved October 10, 2015, from http://dx.doi.org/10.5040/97818496662

Wenger, E. (1998). *Communities of Practice: Learning, Meaning, and Identity.* Cambridge: Cambridge University Press.

Wiliam, D. (2009). An integrative summary of the research literature and implications for a new theory of formative assessment. *In* H. L. Andrade & G. J. Cizek (Eds.), *Handbook of formative assessment*. New York, NY: Taylor & Francis.

Wiliam, D., & Thompson, M. (2007). Integrating assessment with instruction: what will it take to make it work? *In* C. A. Dwyer (Ed.), *The future of assessment: shaping teaching and learning* (pp. 53-82). Mahwah, NJ: Lawrence Erlbaum Associates.

Wiliam, D., Lee, C., Harrison, C., & Black, P. (2004). Teachers developing assessment for learning: Impact on student achievement. *Assessment in Education, 11*, 49-65.

Williams, J. & Jacobs, J. (2004) Exploring the use of blogs as learning spaces in the higher education sector. *Australasian Journal of Educational Technology 20*(2), 232-247.

Williams, M. (2004). Concept mapping. A strategy for assessment. *Nursing Standard, 19*(9), 33 38.

Wolff, A., Zdrahal, Z., Nikolov, A., & Pantucek, M. (2013). *Improving retention: predicting at-risk students by analysing clicking behaviour in a virtual learning environment*. Paper presented at the Proceedings of the Third International Conference on Learning Analytics and Knowledge.

Wyse, D., & Torrance, H. (2009). The development and consequences of national curriculum assessment for primary education in England. *Educational Research, 51*(2), 213-228.

Yancey, K. B. (2009). Electronic portfolios a decade into the twenty-first century: What we know, what we need to know. *Peer Review, 11*(1), 28–32.

Yinger, R., & Clark, M. (1981). *Reflective journal writing: Theory and practice*. East Lansing: Michigan State University, Institute for Research on Teaching.

Yorke, M. (2003) Formative assessment in higher education: moves towards theory and the enhancement of pedagogic practice*. Higher Education 45(*4) 477-501.

Yorke, M. (2005). Formative Assessment in Higher Education: Its Significance for Employability, and Steps Towards Its Enhancement. *Tertiary Education and Management, 11*, 219–238.

Yusuf, J. & Tuisawau, P. (2011). Student attitudes towards the use of e-Portfolios: Experiences from The University of the South Pacific. *Malaysian Journal of Educational Technology, 11*(4), 31-41.

Zaïane, O., & Luo, J. (2001). Web usage mining for a better web-based learning environment. *In Proceedings of conference on advanced technology for education, Banff, Alberta* (pp. 60–64).

Zeichner, K., & Wray, S. (2001). The teaching portfolio in US teacher education programs: What we know and what we need to know*. Teaching and Teacher Education, 17*(5), 613-621

Zinn, C., & Scheuer, O. (2006). Getting to know your student in distance-learning contexts, innovative approaches for learning and knowledge sharing. In *Proceedings of the 1st European conference on technology enhanced learning* (pp. 437–451).

Zou, X. & Zhang, X. (2013). Effect of different score reports of Web-based formative test on students' self-regulated learning. *Computers & Education, 66*, 54-63.

Zubizarreta, J. (2004). *The learning portfolio: Reflective practice for improving student learning*. Bolton, MA: Anker