Regional Directorate
for Primary and Secondary
Education of Attica

CONNECT
SUPPORT ONLINE EDUCATION

THE CONNECT APPROACH HANDBOOK

Flipped Classroom
Blended Learning
Differentiated Instruction
Digital Tools
Collaborative Learning

A Handbook on the implementation of the Flipped Classroom Approach in Secondary Education (Gymnasium) in the context of Mathematics, Physics and Foreign Language

ISBN: 978-618-86131-1-9

EDITING: Dr. Georgios Kosyvas
Regional Director for Primary and Secondary Education of Attica: "CONNECT" Coordinator

PEDAGOGICAL TEAM: Aikaterini Glinou, Constantinos Apostolopoulos, Eftihia Papahristou, Evangelia Karagianni, Ioannis Georgakopoulos, Panagiotis Pefanis, Stylianos Markantonakis

January 2023

#ConnectErasmusProject www.connect-erasmusproject.eu/mooc/

Upskilling of sChools' teachers to effectively support ONliNe EduCaTion

With the support of the Erasmus+ Programme of the European Union

CONNECT - Upskilling of sChools' teachers to effectively support ONliNe EduCaTion
KA2 - Agreement Number : 2020-1-EL01-KA226-SCH-094578

The “CONNECT Approach” Handbook is an intellectual outcome that aims at familiarizing educators with up-to-date teaching practices included in the “CONNECT” approach (with a focus on Flipped Classroom) with a view to upskilling educators aiming at equipping them to carry out the pilot. It encompasses the proceedings of the recent educational events held in Athens in the context of the “CONNECT” Erasmus+ KA2 programme (Learning Teaching Training Activities and European Multiplier Event) directing readers’ attention into the keynote speeches.
The “CONNECT” Approach Handbook constitutes a useful tool that educators can use to reflect on their teaching. The proceedings included in this handbook help educators analyze their teaching methods in the light of the “CONNECT” approach, identifying areas for improvement with a view to developing high-level skills.

The “CONNECT Approach” Handbook can assume the role of a piloting guide in the sense that it helps educators who will carry out the pilot gain knowledge on cardinal concepts, such as flipped classroom, critical didactic incidents, online learning, digital tools, educational scenarios, problem-solving, et.c. This knowledge could be viewed as a valuable asset to the piloting.

The “CONNECT” Approach Handbook has been developed under the auspices of the Regional Directorate for Primary and Secondary Education of Attica as a supplementary material to the presentations and workshops uploaded to the project’s website.

IKY With the support of the Erasmus+ Programme of the European Union
CONNECT - Upskilling of sChools' teachers to effectively support ONliNe EduCaTion
KA2 - Agreement Number : 2020-1-EL01-KA226-SCH-094578

Acknowledgements

We would like to thank all our partners (University of Cyprus, CNR (Italy), CTI Diophantus) for their contribution to the handbook development. We would also be thankful to our pedagogical team for taking on the editing of the handbook. We would also like to thank the National Hellenic Agency for supporting us in every phase of the project, part of which is the handbook development. Finally, we would also like to thank all keynote speakers at the LTTA and EME for providing us with the requisite material to develop the handbook.

See https://connect-erasmusproject.eu for details of the CONNECT (Upskilling of sChools' teachers to effectively support ONliNE EduCaTion) project and the collaboration scheme. CONNECT is a project co-funded by the Erasmus+ Programme of the European Union (Grant Agreement 2020-1-EL01-KA226-SCH-094578). The European Commission support for the production of this publication does not constitute endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Athens, 2023

Table of Contents

LEARNING TEACHING TRAINING ACTIVITIES PROCEEDINGS

. Differentiated Instruction
. Students' Alternative Conceptions
. Flipped Classroom Scenarios
. Collaborative Learning-Problem Solving Practices
. Digital tools' Evaluation
. Inquiry-based Teaching
. Critical Incidents

The need for Upskilling Educators-The “CONNECT” Approach

Dr. Georgios Kosyvas, gkosyvas@gmail.com

Regional Director for Primary and Secondary Education

The COVID-19 pandemic brought about radical changes in the entire educational foundation. The “shutting down” of schools indicated the potential of distance education. In the face of the COVID-19 pandemic, modern educational practices were employed, compensating for face-to-face instruction.

The way was paved for practices combining face-to-face instruction with contemporary teaching methods. In this context, Blended Learning became the prevalent educational approach. It is important to underline that important European Initiatives revolve around up-to-date educational practices. In this spirit, the “CONNECT” approach embraces new educational opportunities stressing the importance of Blended Learning and Flipped Classroom.

The “CONNECT'' project is a joint venture which serves the purpose of upskilling educators in order to implement up-to-date practices such as Blended Learning and Flipped Classroom. The “CONNECT'' potential lies in the fact that European partners learned to collaborate to the same end. They learned to overcome difficulties, to deal with problems and to work the same way to culminate the project. In particular, partners from Greece (Regional Directorate for Primary and Secondary Education of Attica -RDPSEA, Hellenic National Agency and Institute of Computer Technology and Press-CTI Diophantus), partners from Italy (National Research Council-CNR) and partners from Cyprus (University of Cyprus) worked together, shoulder to shoulder and achieved milestones.

It should be noticed that partners from France (GIP FCIP DE PARIS) also participated in the initial phase of the project. It is also important to underline that the Regional Directorate for Primary and Secondary Education of Attica works as a coordinator in this joint effort, providing partners with support and guidance.

The term “upskilling” denotes that the “CONNECT” project does not only aim at helping educators develop basic digital skills but also aspires to help educators develop high-level skills in a way to upskill them. The educators’ upskilling is achieved through valuable intellectual outcomes.

Each intellectual outcome is developed to achieve inclusion and to promote active learning. Given that Flipped Classroom fosters active learning, the Flipped Classroom Model assumes a fundamental role in the “CONNECT” approach. Inclusion is achieved in the sense that the intellectual outcomes developed in the context of the “CONNECT” approach are widely available and they are tailored to the needs of the potential learners. Learners are viewed as active participants and everything that the

"CONNECT" approach encompasses (methods, teaching material, etc.) is adjusted to their needs.

The respective intellectual outcomes aspire to create real learning opportunities for all learners. The training session included in the "CONNECT" approach is also governed by the same principles. It should be stressed that all intellectual outcomes meet specific quality standards. Image 1 depicts the aforementioned intellectual outcomes and the key-note processes included in the "CONNECT" Approach.

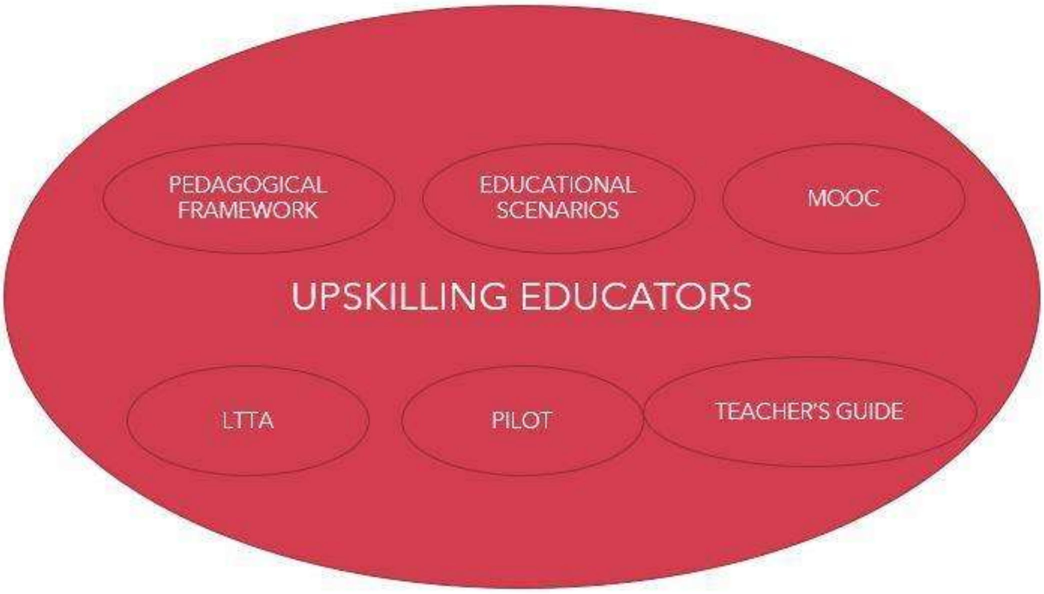


Image 1: Intellectual Outcomes and key-note processes

The Pedagogical Framework revolves around the pedagogical principles and theories on which the entire distance education relies. This intellectual outcome indicates how the aforementioned directions could be used to develop educational scenarios and how digital tools could be incorporated into the learning process.

In addition, it should be highlighted that the educational scenario constitutes a learning unit which is based on specific pedagogical theories. Therefore, in order to develop an educational scenario, educators should be familiarized with the respective theories. The process of an educational scenario development requires more than incorporating digital means. The educational scenarios development process denotes the design and the orchestration of the learning activities that should be completed to implement the respective scenario. In parallel, this process calls for gathering the supportive digital material. Finally, the evaluation method is also included in the underlying process.

Specific guidelines have been developed to equip educators to develop their own educational scenario.

The guidelines help educators understand the basic elements of an educational scenario and how appropriate learning activities could be designed to implement the scenario. In parallel, the guidelines focus on the way the digital means could be incorporated into the educational scenarios' design.

The educational scenarios' development is a course-oriented process. Educational scenarios should be developed in a way to comply with the aims and the objectives of the curricula of specific subjects. Hence, educational scenarios have been developed for Mathematics, Physics/Physical Sciences and Foreign Language. The "CONNECT" educational scenarios developed are to be implemented in secondary education (Gymnasium).

A variety of instructional methods are used in the entire "CONNECT" Approach. Therefore, online learning is efficiently mixed with face-to-face teaching in a way to implement blended learning. The Flipped Classroom approach assumes a crucial role in the "CONNECT" approach. Image 2 illustrates the dominant features of the Flipped Classroom approach. Image 3 highlights the major differences between the Flipped Classroom Approach and conventional teaching.

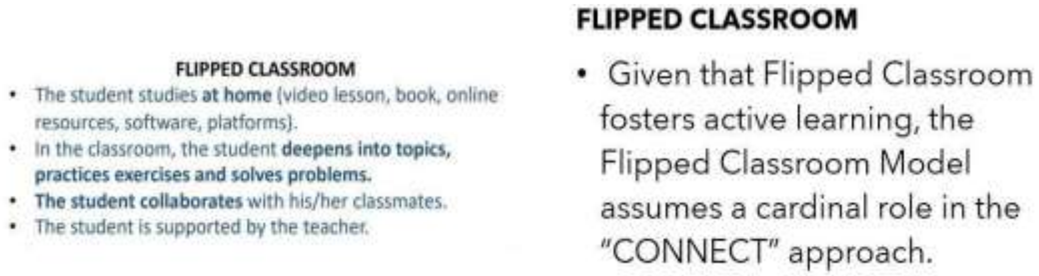


Image 2: The Flipped Classroom Approach Features

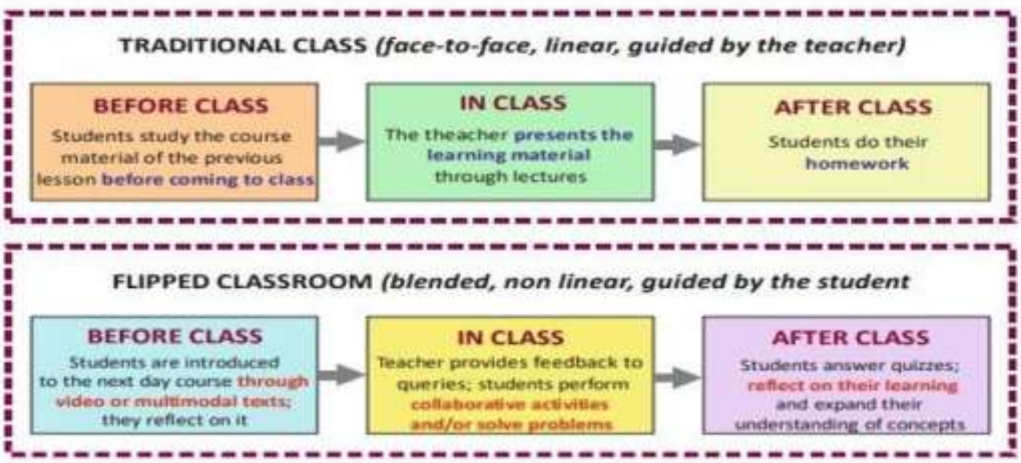


Image 3: Flipped Classroom Vs Traditional Class

With the support of the Erasmus+ Programme of the European Union
CONNECT - Upskilling of sChools' teachers to effectively support ONliNe EduCaTion
KA2 - Agreement Number : 2020-1-EL01-KA226-SCH-094578

Specific MOOC courses have been developed to up-skill educators in the instruction of Mathematics, Physics and Foreign Language in Secondary education. These courses provide educators with the theoretical background in regard to blended learning and help them apply these techniques in their classes. In parallel, MOOC directs attention into the existing educational scenarios. MOOC explain how to develop an educational scenario, presenting specific educational scenarios in the aforementioned subjects. MOOCs training leads to certification on the condition that the activities of all courses have been completed. Image 4 provides the distinguishing characteristics of the MOOC.

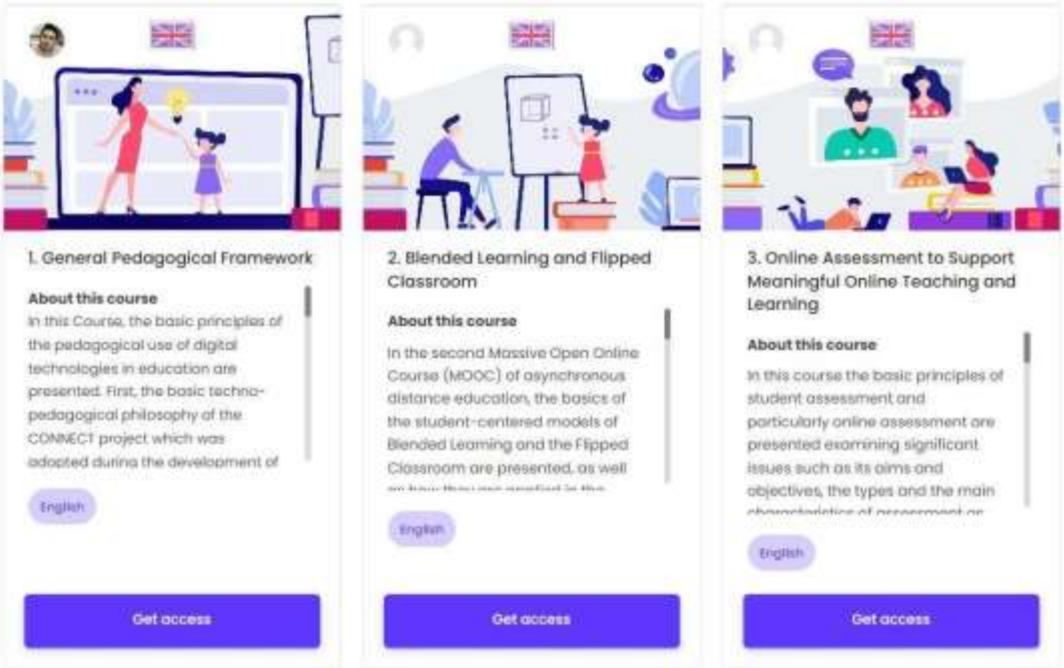


Image 4: The “CONNECT” MOOC

The LTTA event aspires to provide training which could yield fruits. Given that the LTTA is part of the “CONNECT” approach, the “CONNECT” approach encompasses a fruitful training session. The outcomes refer to the ability of educators to apply up-to-date practices in their classes. LTTA, which was held on December 12-14 in Athens, was organized to accomplish this specific purpose.

Educators who have participated in the LTTA training are ready to carry out a pilot implementing Flipped Classroom scenarios in their classes. Three distinct phases stand out in the pilot process as depicted in Image 5.

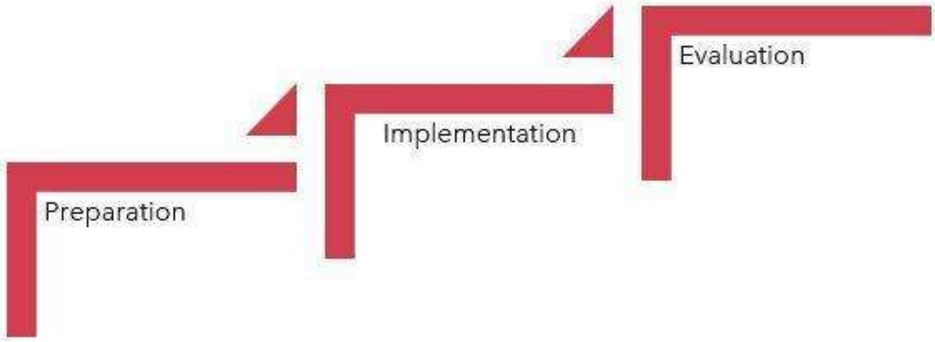


Image 5: Pilot Phases

In the preparatory phase, educators are trained to carry out the pilot. MOOC training along with the LTTA training are organized to meet this primary purpose. In parallel, all requisite tools that could be employed to monitor and control the entire process are developed. The administration authorities of the Schools involved are committed to facilitate educators to perform the pilot implementation process. Educators will be provided with the pedagogical framework, the guidelines on developing educational scenarios and the review of ambassadors. The specific handbook also aspires to contribute to equipping educators to carry out the pilot.

Educators are now ready to perform the pilot implementation process. Mathematicians, Science teachers and Foreign Language teachers should implement Flipped Classroom Scenarios for a specific period of time in order to achieve the goals of each subject in question. During the implementation phase, educators will be supported by coordinators and ambassadors. Meanwhile, stressing the role of ambassadors, it is important to clarify that they are delegated with the responsibility to review the proposed educational scenarios included in the “CONNECT” approach and therefore they are well equipped to help educators culminate the pilot. Coordinators could help educators by consulting them on overcoming difficulties while implementing the respective scenarios. Educators are encouraged to cooperate with each other and this holds true particularly for educators who are assigned to teach the same subject. Peer-to peer review and communities of practice, undoubtedly, could enhance the respective cooperation. In addition, educators should provide feedback by completing the developed questionnaires and the reflection diaries. The administration of the Schools should monitor the pilot implementation process and ensure the feedback sharing.

Data with regard to the implementation process will be analyzed in order to assess the success of the entire venture. The analysis will indicate the outcome of the pilot implementation process among Schools. In parallel, the analyzed data could be compared to subjects. Statistical or other appropriate methods will be used to come up with relevant results.

The teacher's guide will focus on the keynotes of the "CONNECT" approach, providing educators with guidelines on how to apply the education techniques included in the "CONNECT" approach in a way to promote active learning. The teacher's guide directions will be course-oriented. Specific guidelines will be developed for Mathematics, Physics and Foreign Language in a way to comply with their curricula.

The teacher's guide will direct attention into ways to overcome specific difficulties when implementing Flipped Classroom or Blended Learning. Hence, the teacher's guide aims at confirming the educators' upskilling and therefore all educators are encouraged to contemplate on the teacher's guide directions.

All intellectual outcomes along with any other information regarding the "CONNECT" project is available at the websites listed below:

https://connect-erasmusproject.eu

https://pdeattikis.gr/EU/projects/connect/

Differentiated instruction: Insights from EFL teaching

Evangelia Tigka, e_tigka@yahoo.co.uk

Special Needs General Junior High & Vocational High School of Nea Ionia Magnesia, Greece

Abstract

In search for a route towards de-tracking, alignment, and justice in the classroom, differentiated instruction has been suggested as a conscious response to the ever-changing learning population. Teachers are expected to teach proactively and modify curricula, processes, resources, and outputs. However, implementing differentiated strategies has not always been fruitful. Special education is probably the field that triggered the inception of differentiation. In this brief communication, through the teaching of English as a foreign language, a case-study special needs example is presented and a question is posed: Is differentiated instruction appropriate across all educational settings?

Keywords: differentiated instruction, special education, EFL

1. Introduction

The establishment of homogeneous classrooms based on the chronological age criterion disregarding inherent student heterogeneity has been a long-term practice which has masked academic diversity. Particularly over the last years, classrooms have been receiving increasing numbers of learners from various family, socio-cultural, economic, linguistic, religious, and educational backgrounds. Inclusive education has favored the mainstreaming of students diagnosed with disabilities and additional learning needs with non-disabled peers. Talented or intellectually advanced learners are schooled with low achievers. Students with varying degrees of cognitive and emotional engagement, self-confidence, satisfaction, preferences, interests, and diverse learning styles condition the micro-climate, hence, the learning environment of each classroom.

1.1 The outline of differentiation

The focus on de-tracking (Smale-Jacobse et al., 2019; Tomlinson et al., 2003) to enhance educational equity and in-class alignment (UNESCO, 2017) has accentuated the complexity of the teacher's role in terms of attending to learner needs. This mixed-ability mosaic of students requires appropriate addressing with appropriate means. Effective learning calls for effective teaching through the differentiation of classroom routines. Unless individual learning profiles and needs are reflected in the learning process student engagement and performance will be hard to achieve. Differentiated instruction is a pedagogical approach which aims at the academic thriving of the students of a given classroom following a series of conscious decisions made by the teacher. It has been argued (Tomlinson et al., 2003) that teaching may be differentiated across the curriculum (i.e., through student allocation to graded difficulty groups), process (i.e., through teaching methodology adjustment), resources (i.e., through modifying lesson materials), and student outputs (i.e., through suggesting different ways of learning). Moreover, teachers may diversify the allocated time by providing either more for the low achievers or less for advanced students (Coubergs et al., 2013, in Smale-Jacobse et al., 2019).

Differentiated instruction could be viewed as a deliberate re-action to the feedback perceived by the teacher whose purpose is to maximize the potential of all students. Differentiation could be either convergent or divergent (Bosker, 2005, in Smale-Jacobse et al., 2019). By the former term, it is intended that the teacher focuses on the weak students and supports them to attain the top of their potential. Convergent differentiation, which is an act of in-class alignment and justice, minimizes the gap between high and low performers. On the contrary, when the teacher diversifies the lesson without excluding any student and modifies learning objectives, processes, and outputs they apply divergent differentiation. Inherent in differentiated instruction is the belief that learner differences are dynamic, which provides the conditions for adaptable grouping (Coubergs et al., 2017). These differences may vary from cognitive to interests, prior knowledge, and learning profile (Sweller, van Merriënboer, & Paas, 1998; van Merriënboer & Sweller, 2005).

1.2 Teachers' perceptions and hesitations

However, teachers often hesitate or do not successfully implement differentiated practices (Pilten 2016; Roiha 2014). Civitillo, Denessen, & Molenaar (2016) investigated how teachers fathom student variance because this knowledge would urge them into taking further action and address diversity. Corroborating previous research, they concluded that instead of responding *proactively* to in-class differentiations, the participating teachers resorted to *reactive* teaching practices, namely, they had pre-designed the lessons and attempted to tailor them to their students' requirements. Large class sizes and limited access to materials and resources (Tomlinson, 2014, in Civitillo, Denessen, & Molenaar, 2016) may account for the inhibition of implementing differentiated instruction. At a teacher readiness level, though, in-service training as regards differentiated skills development has not been a priority (Civitillo, Denessen, & Molenaar, 2016). Additionally, academic achievement appeared to have weighed more than differentiated teaching, while convergent instruction, i.e., catering for the low achievers, seemed to have been the preferred teaching approach.

2. Approach

Teaching students with disabilities and additional learning needs in a Greek secondary special needs school is a challenging experience because all of the classes are par excellence mixed-ability ones. Each class may receive up to eight students while all of the students attending such a school have been diagnosed with at least one different special need. The academic requirement, apart from having graduated from primary education, is to have mastered linguistic and arithmetic literacies. To provide an indicative real classroom example, the spectrum of special needs could be as broad as follows: a non-Greek speaking boy with severe language impairment, mild intellectual disability, and severe speech disorders (due to family and environmental reasons); a girl with Down's syndrome and mild intellectual disability; a boy with mild intellectual disability and subtle psychiatric issues much older than the rest of his peers; a girl with severe intellectual disorder; and a boy with very serious learning difficulties who had been neglected by his parents. Implementing differentiated strategies in these conditions becomes an absolute necessity because the objective is for each student to reach their utmost potential while being educated along with peers with similar or dissimilar learning needs. Special needs teachers are required to have studied each learner's file before deciding to apply material modifications and adjustments, ways of delivery, and evaluation. They need to be informed of the micro-circumstances of each class, be in a position to recognise the differences among students, and ideally draft a chart of the very topical needs of each class.

2.1 Individualised EFL for students with special needs

Teaching English as a foreign language (EFL) in the educational setting of a secondary special needs school, such as the one already described, constitutes an additional challenge for the educator because students with disabilities and additional learning needs cannot easily perceive the abstractions of the linguistic code, particularly of a foreign one. The massive use of English as a means of daily communication (Kuppens, 2010; Reinders & White, 2011; Sockett, 2014) does not entail that the language will be assimilated, learnt and used by special needs students. An EFL teacher is required to address individualized learning by breaking down strategies into a series of simple steps for the students to engage with the foreign language and start mastering its features. Moreover, safeguarding a supportive and collaborative classroom environment will enable students to ask for and provide support. In order to identify the student's goals, examine teaching strategies, and determine timelines for reviewing goals, the EFL teacher should gather information about each learner's strengths and needs. Conducting a reading, writing, and listening skills assessment would provide insights into visuospatial abilities, decoding strategies, comprehension, handwriting, spelling, written speech organization, recalling skills, instruction following, and phonological awareness. Additionally, the teacher is expected to seek information concerning the learner's family and cultural background. Having established a basis for each student, the teacher may attempt to proceed to the next step, i.e., EFL differentiated teaching.

2.2 Suggested EFL practices

The identification of each student's particular needs, learning profile, and strengths will enable the EFL teacher to address them effectively through appropriate learning tasks, resources and materials. Being open towards individual differences, genuinely supportive, and flexible can be particularly constructive in special education because the objective is for every learner to mark progress over the course of the school year as compared to themselves, not to the rest of the class. The personal trail towards knowledge acquisition entails the granting of sufficient and differentiated time to respond to the plan devised by the teacher. Presenting the language in small chunks will prevent overloading the students with input that may deter them from further engagement with the learning process. Enriching the lesson with multisensory input and practice, such as audio recordings, illustrations or mind maps, physical gestures and movement, music or rhythm, and drama techniques will make the foreign language more accessible to learners with disability and additional learning needs. Naturally, the selection of the appropriate method should be per the individualized condition that each learner bears but also with what the rest of the peers are in a position to handle, tolerate and accept. Accordingly, learner progress assessment should be aligned with the individualized learning plan. Formative assessment is of particular significance since it delineates each student's progress on specific linguistic aspects which need to be addressed and re-assessed.

In essence, the students themselves formulate the EFL teaching in a secondary special needs setting given that their cognitive condition delineates the limits of their potential. The teacher, conscious of this reality, may attempt strategies which will guide each learner towards foreign language mastery. The real challenge for the teacher is the concurrent attendance to the different needs of each learner within the restricted time framework of a school timetable. Additionally, external or unforeseeable variables, to which special needs students are usually susceptible, may confound the setting or even the pre-designed teaching approaches. This calls for extreme readiness, alertness, and flexibility on behalf of the teacher who should respond as swiftly as possible. Apart from the necessary academic knowledge for differentiated instruction implementation, the cultivation and development of affective educational skills are equally crucial in special education.

3. Results

This individualized instruction within the framework of the described secondary special needs school for EFL teaching has not been empirically assessed against any standardized tools that could yield tangible or comparable results. According to the relevant literature, it may not even be classified as differentiated instruction considering the peculiarities of the specific circumstances. Considering the constituent parts of each class in terms of the spectrum of disability diagnoses, this kind of differentiation became a compelling necessity for the EFL teacher to address the specific needs of each student and attempt to instruct them in the foreign language in a way that would approach their unique potential. In the unlikely event of similar learning profiles coincidence, attempting differentiation may have been effective to a certain degree but the differentiated outcomes could be biased and short-term. A means of achieving effective learning within the particular educational setting would be a connection of the students' lives to the actual use of the target language: their participation in international educational programmes would substantiate that their learning is tangled with the human need of communicating through a commonly shared medium.

4. Discussion

This brief communication intended to exemplify a very particular instance of individualized EFL instruction to students diagnosed with various disabilities. Another intention of this article was to ponder over the applicability of differentiated instruction across all educational settings. Secondary special education is a case study per se and greatly varies across countries. Student variance in such educational settings can often be unforeseeable because it is altered by environmental factors that influence demographic characteristics. Above all teaching/learning approaches, however, enhancing engagement, self-confidence, and satisfaction lies at the heart of education because teaching/learning is founded upon a complex neuronal network of reciprocal relationships and interactions.

5. Conclusion

When a teacher genuinely knows their students, it is almost unlikely that they will not implement differentiated instruction, even impulsively. Offering ample opportunity for novel ways of uncovering and discovering knowledge and being guided by individual learning styles are bound to lead each student a step higher than where they had started their quest for knowledge. Displaying empathy towards special needs students equals a conscious act of human respect that may trace the trail towards alternative instruction.

6. References

Civitillo, S., Denessen, E., & Molenaar, I. (2016). How to see the classroom through the eyes of a teacher: Consistency between perceptions on diversity and differentiation practices. *Journal of Research in Special Educational Needs*, *16*(s1), 587–591. http://doi.org/10.1111/1471-3802.12190

Coubergs, C., Struyven, K., Vanthournout, G., & Engels, N. (2017). Measuring teachers' perceptions about differentiated instruction: The DI-Quest instrument and model. *Studies in Educational Evaluation*, *53*, 41–54. https://doi.org/10.1016/j.stueduc.2017.02.004

Kuppens, A. H. (2010). Incidental foreign language acquisition from media exposure. *Learning, Media and Technology*, *35*(1), 65–85. https://doi.org/10.1080/17439880903561876

Pilten, G. (2016). A phenomenological study of teacher perceptions of the applicability of differentiated reading instruction designs in Turkey. *Educational Sciences: Theory & Practice*, *16*(4), 1419–1451. http://doi.org/10.12738/estp.2016.4.0011

Reinders, H., & White, C. (2011). Special Issue Commentary: Learner autonomy and new learning environments. *Language Learning & Technology*, *15*(3), 1–3. Retrieved November 14, 2022 from https://www.lltjournal.org/item/10125-44254/

Roiha, A. S. (2014). Teachers' views on differentiation in content and language integrated learning (CLIL): Perceptions, practices and challenges. *Language and Education*, *28*(1), 1–18. http://doi.org/10.1080/09500782.2012.748061

Smale-Jacobse, A. E., Meijer, A., Helms-Lorenz, M., & Maulana, R. (2019). Differentiated instruction in secondary education: A systematic review of research evidence. *Frontiers in Psychology*, 10:2366. https://doi.org/10.3389/fpsyg.2019.02366

Sockett, G. (2014). *The online informal learning of English.* Palgrave Macmillan.

Sweller, J., van Merriënboer, J. J. G., & Paas, F. (1998). Cognitive architecture and instructional design. *Educational Psychology Review*, *10*(3), 251–296. https://doi.org/10.1023/a:1022193728205

Tomlinson, C. A., Brighton, C., Hertberg, H., Callahan, C. M., Moon, T. R., Brimijoin, K., Conover, L. A., & Reynolds T. (2003). Differentiating instruction in response to student readiness, interest, and learning profile in academically diverse classrooms: a review of literature. *Journal for the Education of the Gifted*, *27*(2-3), 119–145. https://doi.org/10.1177/016235320302700203

UNESCO (2017). *A guide for ensuring inclusion and equity in education*. United Nations Educational, Scientific and Cultural Organization. Retrieved November 14, 2022 from https://unesdoc.unesco.org/ark:/48223/pf0000248254

van Merriënboer, J. J. G., & Sweller, J. (2005). Cognitive load theory and complex learning: Recent developments and future directions. *Educational Psychology Review*, *17*(2), 147–177. https://doi.org/10.1007/s10648-005-3951-0

Connecting Students' Alternative Conceptions in Science with their Hypotheses during the Inquiry-Based Model

Constantina, Stefanidou , sconstant@primedu.uoa.gr

National and Kapodistrian University of Athens

Abstract

This paper deals with the connection between two terms of science education. On the one hand, the term students' "alternative ideas" about natural phenomena, the characteristics of these ideas and their value in modern science teaching are presented. In addition, the term "hypothesis formulation" is presented, which includes the phase of the inquiry model, in which students express their opinion about the outcome of a phenomenon. Whatever the term is, a teacher's deep knowledge of students' views on natural phenomena seems to be of crucial importance, to be able to propose appropriate teaching projects in accordance with the modern currents of science teaching.

Keywords: students' alternative ideas, hypothesis, inquiry-based teaching model

1. Introduction

Alternative ideas are intertwined with the constructivist model of teaching in which either the conflict between students' alternative ideas, which are acceptable at the level of everyday life, as well as scientific ideas, which are acceptable at the classroom level, or the modification of alternative ideas are important. These situations, whether they involve conflict or not, teachers are asked to deal with (Chalkia, 2012).

However, in recent years, the inquiry model of teaching and learning has prevailed as a model suitable for familiarizing students of all levels with scientific methodology, in the sense of familiarizing students with scientific procedures. In the context of the inquiry approach, students are asked to make specific hypotheses about the phenomena under consideration, which also determine the corresponding experiments to confirm or reject them (Skordoulis & Stefanidou, 2021). What follows is a comparison of the two terms, alternative ideas and hypotheses, in order for their relationship and their utilization to be highlighted in the context of modern teaching of the natural sciences.

2. Approach

Students gradually construct their knowledge of the world through their everyday experience inside and outside of school. Many times, the explanations they construct for natural phenomena may not match scientific explanations. These student ideas are known as alternative conceptions or misconceptions (Driver et al., 1994). For example, research shows that almost all students in elementary school believe in a geocentric model. It is important for the teacher to know the perceptions of his students and to try, with appropriate teaching actions, to encourage them to formulate scientifically acceptable explanations. Similarly, many students believe that the human heart produces the blood. It takes time and a lot of effort to present as a fact that the blood is created in the bone marrow and that our heart is just a pump, thanks to which blood circulates in our vessels.

One of the greatest contributions of constructivism to science education is the research on students' alternative ideas. It began with the work of Rosalind Driver and was continued by a multitude of researchers, who dealt with the alternative ideas of students of different ages and different cultures. Although today "alternative ideas" are also called "ideas" of students, the change in terminology, from "ideas" to "alternative ideas" of students, took place after the influence of Cognitive Science and the discharge of childishness or error since corresponding ideas also existed in the History of Science. In “Making Sense of Secondary Science: Research into Children’s Ideas” Driver and her colleagues (Driver et al., 1993) gather students' ideas about various phenomena of the natural world.

Inquiry teaching emerged in science education in the twentieth century. According to Dewey, science teaching focused too much on the accumulation of knowledge, whereas it should put more emphasis on science as a way of thinking and practicing. As he argued, science constitutes not only a body of knowledge but all the processes through which that knowledge is acquired are involved as well (Dewey, 1910). In the 1950s and 1960s, efforts concentrated on inquiry as an approach to science teaching. Joseph Schwab (1960, 1966) had a pivotal role in that. He pointed out that science teaching should be treated as a set of conceptual structures that are readjusted in the light of new data. The implications of Schwab's ideas were significant. According to his view, teachers should present science as inquiry and students need to use inquiry to learn the content of science.

Cognitive competencies related to inquiry extend beyond what we characterize as skills related to scientific processes, such as observation, experimentation, and inference (Millar & Driver, 1987). Competencies related to inquiry require students to be able to relate these processes to scientific knowledge as they use logic and critical thinking to interpret phenomena. The inquiry approach includes five phases, while, depending on the case, they may also be divided into sub-phases (Bybee et al., 2006). In any case, the steps of the inquiry model can intervene each other, in the sense that during the teaching, students can refer to a previous step, either on their own initiative or with the guidance of the teacher. In general, the phases of the inquiry model are as follows (NRC 2000): 1. Engage 2. Hypotheses formulation – Experimentation 3. Explanation 4. Elaboration and evaluation of the results and 5. Communication of the results

3. Results

In the following table the phases of the constructivist and inquiry-based model are presented.

Phases of the constructivist model (Driver, 1988)	Phases of the inquiry-based model (Bybee et al. 2006)
Orientation	Engagement
Generation of ideas	Hypothesis formulation
Restructure of ideas	Experimentation
Application of ideas	Explanation - Elaboration
Reflection	Evaluation – Communication of results

What is concluded is that the inquiry approach incorporates many elements of the constructive approach. Both emphasize student participation and intend to involve students in all stages of instruction. Regarding students' prior knowledge and experiences, it seems that in the constructivist approach, students' ideas have a central role, since their restructuring (or modification) is at the core of this approach.

According to the inquiry approach, students' knowledge and experiences about the phenomenon under consideration are present in the phase of hypothesis formulation, where students have the opportunity to state their point of view on the subject under study. The hypothesis formulation is a phase of scientific inquiry, during which the scientist formulates his/her opinion on the subject under investigation, based on his previous perceptions. Based on the hypothesis, the experimental procedure will also be designed. In the inquiry approach the emphasis is also on familiarizing students with scientific procedures (hypothesis - experimentation - confirmation or refutation of the hypothesis) and not only on the content (laws, concepts, theories, etc.).

4. Discussion - Conclusion

In the previous sections, the role of students' pre-existing ideas and how these ideas are utilized in the context of modern currents in science teaching was discussed. The dominant approach to science teaching today is inquiry, in which emphasis is placed on familiarizing students and teachers at all levels of education with the scientific processes. Such processes include their ability to formulate questions and distinguish them into "why" and "how" questions, designing small inquiries, performing experiments, elaborating and interpreting results.

As per scientific inquiry, the design of the investigation requires the formulation of hypotheses on the part of the researcher, the same applies in the educational laboratory of natural sciences. Suppose, for example, that we intend to teach students that "the temperature of water does not change after boiling as long as it continues to be heated". Whatever the approach, whether constructive or inquiry, the teacher should be aware that the alternative idea associated with this phenomenon is that the temperature of water continues to increase after boiling. Therefore, in the design of the research, in the context of the inquiry approach, after the engagement, and as long as the inquiry is guided, the teacher invites the students to formulate their opinion on the subject in question. Afterwards, the students are asked to propose the experiment with which they will test their hypotheses (Stefanidou et al., 2020). In conclusion, our knowledge of students' ideas about natural phenomena is necessary to approach both the content and the processes of science effectively according to modern currents in science teaching.

5. References

Skordoulis C. & Stefanidou C. (2021). Didactic methodology of science – Theory and practice, Propobos (In Greek)

Chalkia, C. (2012). Teaching Science. Athens: Patakis (In Greek: Χαλκιά, Κ. (2012).

Bybee, R., Taylor, J., Gardner, A., Van Scotter, P., Carlson, J,. Westbrook, A. (2006). The BSCS 5E instructional model: Origins and effectiveness. Colorado Springs, CO: BSCS

Dewey, J. (1910). How we think. Lexington, MA: D.C. Heath

Driver, R. (1988). Theory into practice II: A constructivist approach to curriculum development. Development and dilemmas in science education, 23, 133-149.

Driver, R., Squires, A., Duck, P., Wood-Robinson, V. (1994). Making Sense of Secondary Sciences: Research into Children's Ideas. London: Routledge

Millar, R., & Driver, R. (1987). Beyond Processes. Studies in Science Education, 14, 33-62. http://dx.doi.org/10.1080/03057268708559938

National Research Council 2000. Inquiry and the National Science Education Standards: A Guide for Teaching and Learning. Washington, DC: The National Academies Press. https://doi.org/10.17226/9596.

Schwab, J. (1960). What Do Scientists Do? Behavioral Science, 5(1).

Schwab, J. (1966). The Teaching of Science. Cambridge, MA: Harvard University Press

Stefanidou, C., Stavrou, I., Kyriakou, K. & Skordoulis, C. (2020). Inquiry-based Teaching and Learning in the Context of Pre-service Teachers' Science Education. Universal Journal of Educational Research, 8(11B), 5894-5900.

Physics Scenarios based on the Flipped Classroom teaching approach

Nikolaos Papadimitropoulos [(1)] , npapadimitropoulos@gmail.com

Konstantina Chrysanthakopoulou [(2)] , chrysandina@gmail.com

[(1)] *Science Teacher, Dr., Principal of 8th Junior High School of Korydallos*

[(2)] *Science Teacher, 8th Junior High School of Chalandri*

Abstract

Nine scenarios are presented which have been developed based on the teaching methodology of the flipped classroom. The flipped classroom involves three learning phases. During the first phase the students work at home in an asynchronous distance learning environment. During the second phase they work in a face-to-face learning environment in class and during the third phase in an asynchronous distance learning environment. Properly designed activities can increase students' motivation and engagement and can help the development of Declarative and Procedural knowledge as well as of soft skills.

Keywords: *Flipped Classroom, Digital Tools, Asynchronous Learning Environment, Face-to-face Learning Environment*

1. Introduction

Learning online with digital tools

The rapid development of new technologies, especially the Internet, made available a multitude of new digital learning tools and, as a result, caused methodological changes in educational practices (Torres-Martín et al., 2022) as they replaced or were used alongside teaching tools such as the Science laboratory. During the Covid-19 pandemic, the exploitation of digital learning tools has become a necessity. Schools had to operate in a purely online environment via distance learning environments such as Webex and Zoom, which allow teachers and students to interact in real time (Francescucci & Rohani, 2018; Jia et al., 2023). At the same time, asynchronous distance learning environments such as e-class, Moodle and e-me were available. These environments gave the teacher the opportunity to encompass chat rooms, videos, simulations, virtual labs, questionnaires, games, etc. in the learning process which could engage the students and help them to develop Declarative and Procedural knowledge as well as soft skills.

Nonetheless, the common teaching practice was the use of the synchronous learning environments only for the purpose of presenting long online lectures (Jia et al., 2023). This resulted in reduced student engagement and, inevitably, low learning outcomes, since engagement is directly linked to student motivation and the activation of their cognitive structures (Böheim et al., 2020; Chang & Lan, 2021; Falloon, 2019; Jia et al., 2023; Mamun & Lawrie, 2021; Özgür & Altun, 2021; Sesmiyanti, 2018).

1.2 The Flipped Classroom

Research on the use of physical and digital learning tools has come to contradictory conclusions concerning which type results in better learning outcomes (Gire et al., 2010; George Olympiou & Zacharia, 2018; Zendler & Greiner, 2020). The main reason is that these two types of tools have different affordances (Davenport et al., 2018; Liu et al., 2021; Georgios Olympiou & Zacharia, 2012; George Olympiou & Zacharia, 2018; Sundararajan & Adesope, 2020; Wang et al., 2017; Zacharia & Michael, 2016) which are utilized in a different way by the students' cognitive structures (Rau, 2020; Rau & Schmidt, 2019). As a result, researchers point out that teachers should identify and combine the appropriate affordances while designing the learning process, and not simply choose the type (real or digital teaching tool) (Georgios Olympiou & Zacharia, 2012). They also emphasize that the appropriate use of different affordances in mixed real-digital learning environments can have additive learning outcomes. (Kapici et al., 2019).

The flipped classroom is a blended learning environment that exploits physical and digital tools in order to increase student engagement (Murillo-Zamorano et al., 2019), help them learn at their own pace (Torres-Martín et al., 2022) and provide teachers with the opportunity to use the limited teaching in-class time for the acquisition of higher-order learning outcomes according to Bloom's taxonomy. As a result, researchers conclude that the flipped classroom has better learning outcomes than traditional teaching methods (Chang & Lan, 2021).

More specifically, the flipped classroom approach typically involves three phases (Jia et al., 2023). In the first phase, the students work at home in an asynchronous learning environment, where relevant cognitive schemes are recalled from the students' long-term memory. Then, the introduction to new concepts follows in order to develop mainly declarative knowledge (Papadimitropoulos et al., 2021b; Webster, 2016). During the second phase, students work in the classroom initially implementing activities that will help to recall, check and reconstruct, where necessary, the knowledge developed during the first phase. This knowledge forms the basis for the activities of the second phase, which include experimentation, discussion, collaboration and investigation of issues with the aim of developing learning outcomes related to both declarative and procedural knowledge of the subject. Also, in this phase, students are given the opportunity to develop soft skills through the appropriate activities,as they can interact with each other and with the teacher, they cooperate, calculate, plan, decide and create. Finally, during the third phase, students work at home, in an asynchronous learning environment. In this phase, students engage in reflection activities to achieve metacognitive skills. The results of this phase, additionally, offer the teacher the opportunity to reflect on the lesson he/she organized.

However, it is not always easy for teachers to design a digital learning environment, as they must be able to identify and choose the appropriate tools based on their affordances and the expected learning outcomes (Torres-Martín et al., 2022). At the same time, they should become sufficiently familiar with the stages of reverse order. The "**Connect**" programme facilitates the aforementioned process by implementing flipped classroom teaching scenarios as well as training teachers who could act as multipliers at schools.

2. Approach

2.1 The Scenarios

Nine Junior High School Physics scenarios were developed based on the flipped classroom methodology by representatives of three countries (Cyprus: Konstantina Prokopiou, Greece: Konstantinos Apostolopoulos, Panagiotis Pefanis, Italy: Prof.ssa Silvana Messina, Alberto Forte, Michela Costa). Worksheets (W) and Assessment Sheets (A) have been developed for the scenarios in addition to using digital material such as Google Classroom virtual classes, Videos (V), Virtual Labs (VL), Internet links (L), digital Concept Maps (CM), images (I) and Google Forms questionnaires. Also, physical laboratory instruments and everyday materials are used, with which students have the opportunity to acquire laboratory skills.

Cyprus, 1st Scenario:

Title: Derived quantities of mechanics (surface area, volume, density), their measurements and measuring instruments.

General Objective: Students will understand that a large number of physical quantities are derived from three fundamental quantities of mechanics.

Phase 1: Students study the theory (W1), perform simple measurements with a ruler and calculate the area of a page and the volume of their book (W8). They record their suggestions on how to measure the volume of an irregularly shaped solid object (e.g., a stone).

Phase 2: The students present the results of the measurements and their suggestions for measuring the volume of an irregular shaped solid. The teacher presents the theory of derivatives and fundamental quantities (W1). They measure the area and volume of solids of different shapes (W2-W5) working in groups. They calculate using the formula $\rho=m/V$ the density of solids (W6). After watching a video (V1) with the laboratory measurement of the density of solids, they repeat the process themselves (W7).

Phase 3: Students watch a video (V2) in which the volume and mass of a quantity of water is measured. They use the data of the video to calculate the density of water. They answer a Google Forms multiple choice questionnaire.

Cyprus, 2nd Scenario:

Title: Measurements-Fundamental Quantities of Mechanics

General Objective: Students will get to know the three fundamental quantities of Mechanics (length, time, mass).

Phase 1: Students measure the length and width of an A4 sheet using their hands as instruments. Afterwards, they estimate the mass of the book with their hand. Finally, they estimate the duration of a sound. They are asked to answer why students who took similar measurements had different results and to suggest ways in which they would come to similar ones (W1).

Phase 2: Summary and discussion of distance learning activities. The teacher presents the theory (W1) with an emphasis on the three fundamental quantities and their measurement methods. Then, students work in small groups counting their desk with palms and the classroom with steps (W2). Then, they measure the length of a notebook, a desk and the classroom with a ruler and tape measure (W3) and are asked to convert the units of measurement into multiples and submultiples. They measure the sound duration with a timer and are asked to convert the unit in which they gave the result (W4). They measure the mass of various bodies (W5) and discuss the need to use a common unit of measurement. Finally, they answer a questionnaire about unit definitions and conversions (Assessment Sheet).

Phase 3: Online games are used to assess learning outcomes (Online Questionnaires).

Cyprus, 3rd Scenario:

Title: Rectilinear Smooth Motion

General Objective: Students learn about rectilinear smooth motion

Phase 1: Students watch a video about the movement of a car performing a RSM and record their observations about its position at equal time intervals (W1-q.10).

Phase 2: Checking of student answers. Theory delivery about RSM (Theory Sheet). Exercises (Q1) Bubble tube experiment (W1)

Phase 3: Exercises for knowledge review (Q2)

Greece, 1st Scenario:

Title: Electric Dipoles – Ohm's Law

General Objective: To recognize that electric dipoles exhibit resistance and to inquire the intensity-voltage relationship in order to derive Ohm's law

Phase 1: Pre-existing knowledge is recalled. Then the students observe representations of electrical circuits, V-I diagrams and the concept of a resistor (W1).

Phase 2: Review of Phase 1, students ask the teacher questions. The expected learning outcomes are presented. Students in groups derive Ohm's law in a real or virtual lab and then design an experiment to calculate the resistance of a pencil tip (W2). The students present their results in the class (W3). Finally, they answer a knowledge questionnaire (Q1).

Phase 3: Students answer a knowledge questionnaire, a questionnaire for reflection on the learning processes (Q2) and a Likert questionnaire (Q3) in order to assess the perceived achievement of the expected learning outcomes.

Greece, 2nd Scenario:

Title: Electric circuits, resistor wiring

General Objective: Students will understand the two basic ways they can connect two electric dipoles in a circuit and the characteristics of the circuit.

Phase 1: Students watch two videos of connecting bulbs in series (V1) and in parallel respectively (V2). They then perform the worksheet activities related to the characteristics and calculations in circuits of two light bulbs connected in series and in parallel (W1).

Phase 2: Students in groups implement two circuits in the virtual or real laboratory: in series and in parallel. They perform calculations and compare the two circuits. Then the students evaluate which method of experimentation (virtual or real laboratory) is better for drawing conclusions (W2). They complete the knowledge questionnaires (Q1, Q2).

Phase 3: Likert self-assessment questionnaire is used to assess the degree of achievement of the expected learning outcomes.

Greece, 3rd Scenario:

Title: Refraction

General Objective: The identification and interpretation of phenomena and applications related to the refraction of light.

Phase 1: Students watch videos with impressive experiments on the refraction of light (inverting an arrow, disappearing a glass in sunflower oil and a test tube in glycerin as well as the "flying" ship) (V1). They perform an experiment with the 'broken" pencil in water and try to explain it based on their previous knowledge. They perform an angle measurement experiment in a virtual laboratory (VL) of phet Colorado. Through the problem of the lifeguard's route, the concept of the "fastest" route (W1) is introduced.

Phase 2: A discussion about the phenomena that the students experienced in the 1st phase. Students observe or perform in the lab the experiment with a laser beam passing from the air to a plexiglas and vice versa. They discuss the phenomenon first qualitatively (comparing angles) and then quantitatively (measuring angles) (W2, V2). They complete closed-ended questions as a review (Q1, Q2).

Phase 3: They carry out simple refraction experiments (transmission of a ray from successive liquids in a volumetric cylinder, transmission of a ray in different materials and monitoring the apparent lifting of a coin), try to explain the phenomena (Q3) and complete a self-assessment sheet (Q3-Q5).

Italy, 1st Scenario:

Title: Volcanoes

General Objective: Students will understand the definition and classification of volcanoes

Phase 1: In a virtual Google Classroom the students watch videos about the formation of volcanoes (V1), their eruption (V2) and their classification (V3). Then, they learn and familiarize themselves with terms about the parts of a volcano (Q1) through an online quiz, and finally answer a self-assessment questionnaire of the learning outcomes (Q1).

Phase 2: Images (I) of volcanoes are presented on the interactive board and students are asked, in groups, to note on a worksheet the type of volcano, of the eruption, to identify and write the names of the parts of the volcano and finally to write how the volcano was formed. Student groups exchange answers and assess each other. Next, the teacher performs an experiment of a volcano eruption using soda and vinegar (B4). Finally, students play in groups a quiz game about the concepts they learned. More specifically, they design and ask questions to the other team with the goal of earning points when they answer correctly.

Phase 3: Students draw a digital conceptual map (CM) and then answer a knowledge questionnaire (Q2).

Italy, 2nd Scenario:

Title: Introduction to electricity

General Objective: Students will understand the energy conversions in an electric circuit

Phase 1: Students learn about basic concepts of electricity through videos (V1, V2) and conceptual maps (CM). Then they read the first two pages of the textbook. Then, in a virtual laboratory, they design and familiarize themselves with the main elements of a circuit (VL). Finally, they answer a self-assessment questionnaire (Q1).

Phase 2: Students recap what they learned from phase 1 through an online questionnaire (Q2). Then they design circuits in a virtual laboratory (VL). The teacher then moderates an informal discussion by providing information and asking questions. At the same time, students ask questions and ask for clarifications.

Phase 3: Students answer online knowledge questionnaires (Q3, Q4).

Italy, 3rd Scenario:

Title: Energy and Sustainability

General Objective: Students will understand the framework of the Global Goals for Sustainable Development, will understand what renewable energy sources are and what actions will contribute to their more frequent use.

Phase 1: Students read the Global Goals online (L1) and watch videos (V1) about the global spread of the use of renewable energy sources. Finally, they answer an online self-assessment questionnaire (Q1).

Phase 2: Discussion about renewable and non-renewable energy sources, focusing on the advantages and limitations of renewable energy sources (L2-L7). They answer an online self-assessment questionnaire (Q2).

Phase 3: The students in groups of four, search and record information about specific renewable energy sources (Q1).

3. Discussion

The scenarios make extensive use of digital teaching tools such as videos and online texts. During the first phase of the flipped classroom, these tools are used to help students initially build Declarative knowledge. This is the knowledge of "What" and includes facts, names, concepts and relations between concepts (Papadimitropoulos et al., 2021a). It is the prerequisite for the construction of Procedural Knowledge, which is the knowledge of "How" (Anderson, 2013; Hong et al., 2018; Sariscsany & Pettigrew, 1997; Stevenson, 1998). The main learning process in developing declarative knowledge is understanding concepts (Hong et al., 2018). It is important that the learning environment can activate students' cognitive structures. This can be done by increasing interest through the utilization of everyday life topics (Broman et al., 2020; Vogelzang et al., 2019). Cognitive structures are also aided through the recall of relevant cognitive schemas from students' long-term memory, through learning at the student's own pace, and through increased initial guidance (Sweller, 2020). Recall of cognitive schemas relevant to new knowledge, learning at the learner's pace, and increased guidance are particularly important in assisting students' cognitive mechanisms as described by cognitive load theory (Feldon et al., 2019; Mayer, 2014; Mayer & Moreno, 2002; Sweller, 1994, 2011; Upu, 2021).

During the second phase in most scenarios the declarative knowledge, which was developed during the first phase, is recalled and checked. The correct structure of declarative knowledge must be developed in this phase especially while procedural knowledge. This knowledge is based on sufficient declarative knowledge which is applied to appropriate activities (Hong et al., 2018). In specific scenarios, the second phase has also provided the appropriate context to utilize the actual laboratory where students can develop their laboratory skills as well as soft skills.

Finally, during the third phase, the students are given the opportunity to reflect on the activities and knowledge acquired in order to develop metacognitive skills and assimilate the new knowledge into appropriate cognitive schemas (Wood Daudelin, 1996). This phase also gives an opportunity to the teacher to record the students' attitudes towards the lesson.

4. Conclusion

The results from the analysis of the scenarios showed that an attempt was made to follow the principles of flipped classroom phases by using digital and physical representations. Scenario activities can increase student motivation and engagement in the learning process. They also help students' cognitive mechanisms in building Declarative and Procedural knowledge as well as developing soft skills.

However, corrections are required, enrichment and better time management. The need for improvement highlights the necessity for training on the use of the flipped classroom to further familiarize teachers with its principles and the use of digital technologies. It is also useful to draw additional conclusions from the implementation of the scenarios in the classroom in order to explore their advantages and disadvantages in achieving the expected learning outcomes.

5. References

Anderson, J. R. (2013). *The architecture of cognition*. Psychology Press.

Böheim, R., Urdan, T., Knogler, M., & Seidel, T. (2020). Student hand-raising as an indicator of behavioral engagement and its role in classroom learning. *Contemporary Educational Psychology*, *62*, 101894. https://doi.org/10.1016/j.cedpsych.2020.101894

Broman, K., Bernholt, S., & Christensson, C. (2020). Relevant or interesting according to upper secondary students? Affective aspects of context-based chemistry problems. *Research in Science & Technological Education*, 1-21. https://doi.org/10.1080/02635143.2020.1824177

Chang, M.-M., & Lan, S.-W. (2021). Flipping an EFL classroom with the LINE application: students' performance and perceptions. *Journal of Computers in Education*, *8*(2), 267-287. https://doi.org/10.1007/s40692-020-00179-0

Davenport, J. L., Rafferty, A. N., & Yaron, D. J. (2018). Whether and How Authentic Contexts Using a Virtual Chemistry Lab Support Learning. *Journal of Chemical Education*, *95*(8), 1250-1259. https://doi.org/10.1021/acs.jchemed.8b00048

Falloon, G. (2019). Using simulations to teach young students science concepts: An Experiential Learning theoretical analysis. *Computers & Education*, *135*, 138-159. https://doi.org/10.1016/j.compedu.2019.03.001

Feldon, D. F., Callan, G., Juth, S., & Jeong, S. (2019). Cognitive Load as Motivational Cost. *Educational Psychology Review*, *31*(2), 319-337. https://doi.org/10.1007/s10648-019-09464-6

Francescucci, A., & Rohani, L. (2018). Exclusively Synchronous Online (VIRI) Learning: The Impact on Student Performance and Engagement Outcomes. *Journal of Marketing Education*, *41*(1), 60-69. https://doi.org/10.1177/0273475318818864

Gire, E., Carmichael, A., Chini, J. J., Rouinfar, A., Rebello, S., Smith, G., & Puntambekar, S. (2010). *The effects of physical and virtual manipulatives on students' conceptual learning about pulleys*. Proceedings of the 9th International Conference of the Learning Sciences - Volume 1, Chicago, Illinois.

Hong, J., Pi, Z., & Yang, J. (2018). Learning declarative and procedural knowledge via video lectures: cognitive load and learning effectiveness. *Innovations in Education and Teaching International*, *55*(1), 74-81. https://doi.org/10.1080/14703297.2016.1237371

Jia, C., Hew, K. F., Jiahui, D., & Liuyufeng, L. (2023). Towards a fully online flipped classroom model to support student learning outcomes and engagement: A 2-year design-based study. *The Internet and Higher Education*, *56*, 100878. https://doi.org/10.1016/j.iheduc.2022.100878

Kapici, H. O., Akcay, H., & de Jong, T. (2019). Using Hands-On and Virtual Laboratories Alone or Together—Which Works Better for Acquiring Knowledge and Skills? *Journal of Science Education and Technology*, *28*(3), 231-250. https://doi.org/10.1007/s10956-018-9762-0

Liu, C. C., Hsieh, I. C., Wen, C. T., Chang, M. H., Fan Chiang, S. H., Tsai, M.-J., Chang, C. J., & Hwang, F. K. (2021). The affordances and limitations of collaborative science simulations: The analysis from multiple evidences. *Computers & Education*, *160*, 104029. https://doi.org/10.1016/j.compedu.2020.104029

Mamun, M. A. A., & Lawrie, G. (2021). Factors affecting student behavioral engagement in an inquiry-based online learning environment.

Mayer, R. E. (2014). Incorporating motivation into multimedia learning. *Learning and Instruction*, *29*, 171-173. https://doi.org/10.1016/j.learninstruc.2013.04.003

Mayer, R. E., & Moreno, R. (2002). Aids to computer-based multimedia learning. *Learning and Instruction*, *12*(1), 107-119. https://doi.org/10.1016/S0959-4752(01)00018-4

Murillo-Zamorano, L. R., López Sánchez, J. Á., & Godoy-Caballero, A. L. (2019). How the flipped classroom affects knowledge, skills, and engagement in higher education: Effects on students' satisfaction. *Computers & Education*, *141*, 103608. https://doi.org/10.1016/j.compedu.2019.103608

Olympiou, G., & Zacharia, Z. C. (2012). Blending physical and virtual manipulatives: An effort to improve students' conceptual understanding through science laboratory experimentation. *Science Education*, *96*(1), 21-47. https://doi.org/10.1002/sce.20463

Olympiou, G., & Zacharia, Z. C. (2018). Examining Students' Actions While Experimenting with a Blended Combination of Physical Manipulatives and Virtual Manipulatives in Physics. In T. A. Mikropoulos (Ed.), *Research on e-Learning and ICT in Education: Technological, Pedagogical* *and Instructional Perspectives* (pp. 257-278). Springer International Publishing. https://doi.org/10.1007/978-3-319-95059-4_16

Özgür, A., & Altun, A. (2021). Emotional Design and Engagement With Multimedia Learning Materials in E-Learning (*Motivation, Volition, and Engagement in Online Distance Learning* (pp. 168-191). IGI Global.

Papadimitropoulos, N., Dalacosta, K., & Pavlatou, E. (2021a). Teaching Chemistry with Arduino experiments in a mixed virtual-physical learning environment. *Journal of Science Education and Technology*, *30*(4), 550–566. https://doi.org/10.1007/s10956-020-09899-5

Papadimitropoulos, N., Dalacosta, K., & Pavlatou, E. A. (2021b). Teaching Chemistry with Arduino Experiments in a Mixed Virtual-Physical Learning Environment. *Journal of Science Education and Technology*, *30*(4), 550–566. https://doi.org/10.1007/s10956-020-09899-5

Rau, M. A. (2020). Comparing Multiple Theories about Learning with Physical and Virtual Representations: Conflicting or Complementary Effects? *Educational Psychology Review*, *32*, 297–325. https://doi.org/10.1007/s10648-020-09517-1

Rau, M. A., & Schmidt, T. A. (2019, 2019//). Disentangling Conceptual and Embodied Mechanisms for Learning with Virtual and Physical Representations. (Ed.),^(Eds.). Artificial Intelligence in Education, Cham. https://doi.org/10.1007/978-3-030-23204-7_35

Sariscsany, M. J., & Pettigrew, F. (1997). Effectiveness of Interactive Video Instruction on Teacher’s Classroom Management Declarative Knowledge. *Journal of Teaching in Physical Education*, *16*(2), 229-240. https://doi.org/10.1123/jtpe.16.2.229

Sesmiyanti, S. (2018). Student’s Cognitive Engagement in Learning Process. *Journal Polingua : Scientific Journal of Linguistics, Literature and Education*, *5*, 48-51. https://doi.org/10.30630/polingua.v5i2.34

Stevenson, J. (1998). Performance of the cognitive holding power questionnaire in schools. *Learning and Instruction*, *8*(5), 393-410. https://doi.org/10.1016/S0959-4752(97)00029-7

Sundararajan, N., & Adesope, O. (2020). Keep it Coherent: A Meta-Analysis of the Seductive Details Effect. *Educational Psychology Review*. https://doi.org/10.1007/s10648-020-09522-4

Sweller, J. (1994). Cognitive load theory, learning difficulty, and instructional design. *Learning and Instruction*, *4*(4), 295-312. https://doi.org/10.1016/0959-4752(94)90003-5

Sweller, J. (2011). CHAPTER TWO - Cognitive Load Theory. In J. P. Mestre & B. H. Ross (Eds.), *Psychology of Learning and Motivation* (Vol. 55, pp. 37-76). Academic Press. https://doi.org/10.1016/B978-0-12-387691-1.00002-8

Sweller, J. (2020). Cognitive load theory and educational technology. *Educational Technology Research and Development*, *68*(1), 1-16. https://doi.org/10.1007/s11423-019-09701-3

Torres-Martín, C., Acal, C., El-Homrani, M., & Mingorance-Estrada, Á. C. (2022). Implementation of the flipped classroom and its longitudinal impact on improving academic performance. *Educational Technology Research and Development*, *70*(3), 909-929. https://doi.org/10.1007/s11423-022-10095-y

Upu, H. (2021). Constructivism versus Cognitive Load Theory: In Search for an Effective Mathematics Teaching. *arXiv preprint arXiv:2108.04796*.

Vogelzang, J., Admiraal, W., & Driel, J. (2019). Scrum Methodology as an Effective Scaffold to Promote Students' Learning and Motivation in Context-based Secondary Chemistry Education. *Eurasia Journal of Mathematics, Science and Technology Education*, *15*, 1783. https://doi.org/10.29333/ejmste/109941

Wang, J.-Y., Wu, H.-K., & Hsu, Y.-S. (2017). Using mobile applications for learning: Effects of simulation design, visual-motor integration, and spatial ability on high school students' conceptual understanding. *Computers in Human Behavior*, *66*, 103-113. https://doi.org/10.1016/j.chb.2016.09.032

Webster, R. (2016). Declarative knowledge acquisition in immersive virtual learning environments. *Interactive Learning Environments*, *24*(6), 1319-1333. https://doi.org/10.1080/10494820.2014.994533

Wood Daudelin, M. (1996). Learning from experience through reflection. *Organizational Dynamics*, *24*(3), 36-48. https://doi.org/10.1016/S0090-2616(96)90004-2

Zacharia, Z. C., & Michael, M. (2016). Using Physical and Virtual Manipulatives to Improve Primary School Students' Understanding of Concepts of Electric Circuits. In M. Riopel & Z. Smyrnaiou (Eds.), *New Developments in Science and Technology Education* (pp. 125-140). Springer International Publishing. https://doi.org/10.1007/978-3-319-22933-1_12

Zendler, A., & Greiner, H. (2020). The effect of two instructional methods on learning outcome in chemistry education: The experiment method and computer simulation. *Education for Chemical Engineers*, *30*, 9-19. https://doi.org/10.1016/j.ece.2019.09.001

Collaborative Learning and problem-solving practices in the instruction of Mathematics in secondary education

Georgios Kosyvas [1], gkosyvas@gmail.com

Aikaterini Glinou [2], glinouk@gmail.com

[1] *Regional Directorate for Primary and Secondary Education of Education of Attica*
[2] *Educational Coordinator for Mathematics*

Abstract

This paper presents the application of a pilot problem-solving teaching practice to fifteen-year-old students. More specifically, the students were given a problem dealing with a specific mathematical concept. The findings proved that enhancing students' collaboration resulted in better development of arithmetic and algebraic strategies.

Keywords: collaborative learning, problem solving, multiple solution strategies, differentiation.

1. Introduction

A lot of researchers have emphasized the importance of engaging students in problem-solving activities related to real mathematical concepts (Schroeder & Lester, 1989; Schukajlow & Krug, 2014; Große, 2014; Cai & Cifarelli, 2005; Silver et al., 2005; Kosyvas, 2016). Students' involvement in different problem-solving methods results in developing a reasoning that enables them to explore important mathematical ideas and to achieve the learning objectives dictated by the Curriculum (Schoenfeld, 1992; NCTM, 1991). According to research data, problem-solving practices contribute to the development of high cognitive and communicative skills and to the enhancement of students' conceptual understanding (Van de Walle, 2003; Kosyvas, 2017). Problem-solving activities in the classroom allow students to improve, combine, and modify the knowledge that has been acquired (Hiebert et al., 1997).

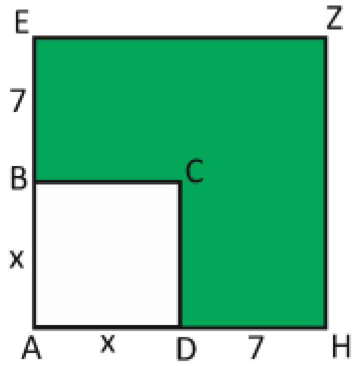
This study presents the way students dealt with a real problem, focusing on their inquiry, on the utilized methods and on their reasoning. The research objective is directed into examining the effect of employing various approaches on the increase of mathematical conceptual understanding. In parallel, the research endeavors to analyze the role that collaborative learning and differentiated teaching assume in developing high cognitive skills.

2. Approach

A qualitative research was carried out based on the combination of paradigm and experiment. Our approach was heavily dependent on participants' observation (Cobb et al., 2003). Experimental teaching was conducted in a class of a specific secondary school (Gymnasium) in Athens. The multiple students' problem-solving practices are analyzed in the light of students' reasoning with a view to identifying learning opportunities.

Defining the Problem

The AEZH figure depicts a specific square that is going to be constructed at a municipal park. The ABCD square (defined by side x) is going to be paved with gravel whereas the shaded part is going to be covered with grass. The lawn area should be 189 m^2. What is the value of the x side, given that BE=DH=7 m?



In this real problem Algebra is related to Geometry. Twenty-four students divided into six groups of four participated in the problem-solving activity. The participants worked in small heterogeneous groups, which consisted of one very good student, two average students and one weak student. These groups were deemed to be equivalent in terms of students' mathematical skills. Students should provide a solution to the problem at the predetermined time (typical class time). Students were also supported by their teachers.

Three distinct phases stand out in the problem-solving activities in class:

Problem understanding (5 minutes): The students were asked to read the problem carefully and to start exchanging ideas. The teacher discussed the problems with all groups in order to answer questions.

Cooperative research (about 20 minutes): After their initial conceptual understanding, the students were asked to identify multiple solutions. Therefore, the students were involved in teamwork in the context of which various strategies were analyzed to develop a concrete indicative solution. The members of each group were invited to agree on the proposed solution. The final solution was written on an A4 sheet of paper.

Class discussion (20 minutes): Each method was critically evaluated by the entire class. The proposed method was considered in the light of assumptions, reasoning and sequence of steps. The teacher did not take over the entire evaluation process. The teacher only provided guidance when needed. However, the teacher stressed the importance of the selected method at the end.

3. Results

It is important to underline that one group solved the problem using a numeric table, another achieved the intended result by using sequential focused trials, another group selected random trials and an incorrect algebraic equation whereas 3 other groups came up with a correct algebraic equation.

Solution 1: Numeric Table

Students used a systematic approach. At first, they created a table to organize their observations. Then they selected the numeric solution that satisfies the conditions of the problem.

x=2	$(x+7)^2= (2+7)^2=9^2=81$	$x^2= 2^2=4$	81-4=77	false
x=3	$(x+7)^2= (3+7)^2=10^2=100$	$x^2= 3^2=9$	100-9=91	false
x=4	$(x+7)^2= (4+7)^2=11^2=121$	$x^2= 4^2=16$	121-16=105	false
x=5	$(x+7)^2= (5+7)^2=12^2=144$	$x^2= 5^2=25$	144-25=119	false
x=6	$(x+7)^2= (6+7)^2=13^2=169$	$x^2= 6^2=36$	169-36=133	false
x=7	$(x+7)^2= (7+7)^2=14^2=196$	$x^2= 7^2=49$	196-49=147	false
x=8	$(x+7)^2= (8+7)^2=15^2=225$	$x^2= 8^2=64$	225-64=161	false
x=9	$(x+7)^2= (9+7)^2=16^2=256$	$x^2= 9^2=81$	256-81=175	false
x=10	$(x+7)^2= (10+7)^2=17^2=289$	$x^2= 10^2=100$	289-100=189	true

The students who created the underlying table did not come up with an algebraic solution.

Solution 2: Randomized Trials

Students collected responses by employing a specific method called: “By trial and Error” without sufficient justification. Some students immediately guessed the solution without accounting for their selection to their classmates. For example, students in one group wrote:

In case **x=1**, the area of the large square will be $8^2=64$, the area of the small square will be $1^2=1$ and the area of the green grass will be: 64-1=63. This is wrong, because the entire grass area is 189 and not 63.

In case **x=10**, the area of the large square will be $17^2=289$, the area of the small square will be $10^2=100$ and the area of the green grass will be: 289-100=189. This is correct, because the entire grass area is 189.

Analyzing the students’ reasoning, we can deduce that students resorted to numeric tests, without testing their validity and they randomly came up with the correct solution.

Solution 3: Sequential Arithmetic Trials (Manually)

Two groups of students selected Sequential Arithmetic Trials in the way are explained below:

At first, students set **x=6** and they calculated the area of the large square AEZH, then they calculated the area of the small square ABCD and finally calculated the area of the lawn:

$13^2- 6^2=169-36=$**133<189**

Students thought that in order to find the solution they should solve the equation by using a number greater than 6. Students trials are listed below:

*Case **x=12**:*

*$19^2- 12^2=361-144=$**217>189***

Trying numbers between 6 and 12:

*Case **x=7**: 14^2- 7^2=196-49=**147<189***

*Case **x=11**: 18^2- 11^2=324-121=**203>189***

*The solution appears to be between 7 and 11. We tried **x=9** and concluded that we should go up one numeric unit.*

Case x=10**: 17^2- 10^2=289-100=**189=189

Students came up with the correct solution, **x=10**. They applied focused sequential trials and accurately approached the solution of the problem (x=10). The way students worked is in line with a specific study (Polya, 1962).

Solution 4: Algebraic Equation

The previous strategies did not require high level mathematical cognitive skills. A simple understanding of the nature of the problem was only needed to come up with an answer. Nevertheless, in the context of an algebraic approach, students individually and as a group should justify their conjectures and should develop a strategy based on an appropriate algebraic equation.

Their reasoning is explained below:

At first, the area of the square AEZH could be written as a function of x: $(x+7)^2$

In parallel, the area of the square ABCD could also be written as a function of x: x^2

Working the same way, the area of the lawn could be written as a function of x: $(x+7)^2 - x^2$

Given that the lawn area should be 189m² we came up with the final equation:

$$(x+7)^2 - x^2 = 189$$

Solving the equation in a sequence of steps:

$$x^2 + 2x7 + 7^2 - x^2 = 189$$

$$14x + 49 = 189$$

14x=140

x=10

The value x=10 constitutes an acceptable solution given that the length AB=x=10>0.

4. Discussion

The findings indicated that students approached the same problem by developing different strategies based on their reasoning. It is important to point out that even “no achievers” (students who usually fail in achieving the intended academic outcome) managed to come up with a solution helped by “achievers” (students who usually achieve the intended academic outcome). Hence, it appeared that collaborative learning yielded fruits.

Students’ solutions accentuated the potential of the algebraic approach. Students realized that in contrast to an algebraic approach, arithmetic approaches could only be viewed as special cases (Herscovics & Linchevski, 1994; Linchevski & Herscovics, 1996).

Solving the problem in different ways enhanced students' inquiry, increased students' engagement and contributed to students' mathematical creativity and critical thinking (Voica & Singer, 2011; Cai & Cifarelli, 2005; Lester, 1994; Schukajlow & Krug, 2014; Große, 2014). Teamwork and discussion in class served the aforementioned purpose given that students had the opportunity to build up their knowledge and develop new arguments.

It is also essential to underline that teachers commented on students' approach exploiting the mathematical experiences of each group. This technique, which was based on the principles of differentiated teaching, enabled students to make new conceptual associations and to create rich mathematical experiences (Willoughby, 1990).

5. Conclusion

This study indicates that urging students to solve a problem in different ways contributes to students' mathematical upskilling. Teamwork and differentiated teaching are of paramount importance. Additionally, the research findings stressed the importance of algebraic strategies. In parallel, the study explains how real problems could be used to relate geometry to algebra. The research also clarified the role of teachers in a problem-solving approach. Teachers should not take over the problem-solving process, taking overall control of the entire process but they should allow for students' intervention in the solution-making process, urging students to take the initiative. Finally, the study pointed out that a collaborative problem-solving approach could result in students' active participation. Therefore, such an approach complies with the objectives of the "CONNECT" European programme.

6. References

Cai, J., & Cifarelli, V. V. (2005). Exploring mathematical exploration: How two college students formulated and solved their own mathematical problems? *Focus on Learning Problems in Mathematics*, *27*(3), 43–72.

Cobb, P., Confrey, J., diSessa, A., Lehrer, R. & Schauble, L. (2003). Design experiment in Educational Research. *Educational Researcher*, *32*(1), 9-13.

Große, C. S. (2014). Mathematics learning with multiple solution methods: effects of types of solutions and learners' activity. *Instructional Science*, *42*, 715-745.

Herscovics, N., & Linchevski, L. (1994). A cognitive gap between arithmetic and algebra. *Educational Studies in Mathematics, 27*, 59–78.

Hiebert, J., Carpenter, T. P, Fennema, E., Fuson, K. C., Wearne, D., ... Murray, H. (1997). Making sense: Teaching and learning mathematics with understanding. Portsmouth, NH: Heinemann.

Kosyvas, G. (2016): Levels of arithmetic reasoning in solving an open-ended problem. *International Journal of Mathematical Education in Science and Technology*, 47 (3), 356–372.

Kosyvas, G. (2017). Exploring trigonometric ratios in authentic workplace contexts. *Mathematics Teaching, 257*, 40-43.

Lester, F. K., Jr. (1994). Musings about mathematical problem-solving research: 1970-1994. *Journal for Research in Mathematics Education* (Special Issue), *25*, 660-675.

Linchevski, L., & Herscovics, N. (1996). Crossing the cognitive gap between arithmetic and algebra: Operating on the unknown in the context of equations. *Educational Studies in Mathematics*, *30*(1), 39–65.

National Council of Teachers of Mathematics (NCTM) (1991). *Professional standards for teaching mathematics*. Reston, VA: Author.

Polya, G. (1962). *Mathematical Discovery: On understanding, learning, and teaching problem solving*. New York: John Wiley.

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense making in mathematics. In D., Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 334-370). New York: McMillan.

Schroeder, T. L., & Lester, F. K., Jr. (1989). Developing understanding in mathematics via problem solving. In P. R. Trafton (Ed.), *New directions for elementary school mathematics, 1989 yearbook of the National Council of Teachers of Mathematics (NCTM*) (pp. 31-42). Reston, VA: NCTM.

Schukajlow, S. & Krug, A. (2014). Do Multiple Solutions Matter? Prompting Multiple Solutions, Interest, Competence, and Autonomy. *Journal for Research in Mathematics Education*, *45*(4), 497– 533.

Silver, E. A., Ghousseini, H., Gosen, D., Charalambous, C. Y., & Font Strawhun, B. T. (2005). Moving from rhetoric to praxis: Issues faced by teachers in having students consider multiple solutions for problems in the mathematics classroom. *Journal of Mathematical Behavior*, *24*, 287-301.

Van de Walle, J. A. (2003). Designing and selecting problem-based tasks. In F. K. Lester, Jr., & R. I. Charles (Eds.), *Teaching mathematics through problem solving: Prekindergarten-grade 6* (pp. 67- 80). Reston, VA: National Council of Teachers of Mathematics.

Voica, C., & Singer, F. M. (2011). Creative contexts as ways to strengthen mathematics learning. In Mihai Anitei, Mihaela Chraif and Cristian Vasile (Eds.), Proceeding on PSIWORLD, Procedia SBS, 33, 2012, 538–542.

Willoughby, S. S. (1990). Mathematics education for a changing world. Alexandria, VA: Association for Supervision and Curriculum Development.

Critical Incidents: Mathematics Teachers’ Attention to Teaching And Learning

Christos Souralis , c.souralis@gmail.com

Ph.D. candidate at the Faculty of Mathematics Department, National and Kapodistrian University of Athens

Abstract

Researchers and teacher educators in their effort to gain access to teaching and its development are using the concept of the critical incident which refers to what teaching moments a teacher considers significant and shifts his attention towards them. The present research is focusing on what CIs prospective teachers attend during their participation in an undergraduate teaching practice course. Rotem and Ayalon's (2022) theoretical lens along with the narrative arc concept empowered the researcher to gain better access to teaching. It is concluded that prospective teachers’ attention moved from CIs acted by teachers to CIs acted by students and from CIs focused on teaching practices to CIs focused on mathematical thinking. Most CIs are about the actor’s thinking.

Keywords: Critical incidents, noticing, prospective teachers, mathematics

1. Introduction

An important aspect of knowledge is *knowing to* use the knowledge at the exact moment it is needed (Mason, 1999) like a geometer who knows when to draw a supportive line or a teacher who attends an important event during his teaching. The other aspects of Mason’s framework of knowledge are *knowing what* to do, *how* to do it, and *why*. These moments of attention along with a reasoning about them and a suitable teaching response create the notion of noticing (Amador & Carter, 2018. Potari & Psycharis, 2018. Van Es & Hand & Mercado, 2017. Souralis, 2022. Warshauer & Starkey & Herrera & Smith, 2019), an important professional skill (Taylan, 2007. Jacobs & Lamb & Philipp, 2010).

The term Critical Incident (CI) is usually defined as a teaching moment that a teacher attends to and considers to be significant (Goodell, 2006. Skott, 2001. Potari & Psycharis, 2018. Souralis, 2022). The CI concept is used by teacher educators and researchers to gain access to teaching and learning phenomena and trigger the professional development of mathematics teachers. Although other researchers do not label the concept as CI, they use the teaching moments the teachers identify as significant, to study the teachers’ noticing skills (Callejo & Zapatera, 2017. Amador & Carter, 2018. Van Es & Sherin, 2006. Star & Strickland, 2008). The 3-dimensional noticing concept consists of the dimensions: attend to, explain, and respond accordingly (Potari & Psycharis, 2018). Goodell (2006) frames CIs by the dimensions: understanding, classroom management, student motives, student relations, and student behavior while Van Es and Sherin (2006) frame the CIs by the dimensions Who and What. Van Es & Sherin (2006) are studying what teachers attend to during teaching and how they explain it and their development through a professional development programme. They concluded that teachers finally focus on students’ mathematical thinking.

Rotem and Ayalon (2022) are studying the kind of CIs teachers attend to. They are using a narrower definition of CIs describing them as teaching moments where the students' thinking about mathematics is clear and creates opportunities for them to have a deeper understanding. Their framework consists of the dimensions: Teaching & Learning, Agency, and Topic. In the teaching & learning dimension, the analyses showed 3 categories: affective (if it is about emotions), cognitive (individual), and social (it reveals some kind of interaction with others such as: the teacher connects students' ideas). The framework and the usage of CIs by teachers, educators, and researchers and the development opportunities it creates is a significant research area (Rotem & Ayalon, 2022).

2. Approach

The research questions that give a direction to the present research are:

RQ1: *What CIs do the prospective teachers attend?*

RQ2: *How prospective teachers' attention is developed through their participation in a teaching practice undergraduate course?*

2.1 Theoretical Framework

Mathematics teaching is a social phenomenon (Mellone, 2011) and to study it, a researcher should use a CI framework that grasps all of its aspects. Rotem's (2022) model (agency, topic, teaching & learning) builds up from Van Es & Sherin's (2002) framework and adds the dimension of teaching & learning. Due to its usage in the present research, the term agency was replaced by the term actor which refers to the person who acts in the teaching incident. The topic dimension refers to the content of the incident's interactions. The model's 3rd dimension categories are cognitive, social, and affective and their meaning was adapted to the data. A CI is characterized as affective if it refers to the actor's feelings, cognitive if it refers to the actor's actions, and social if it refers to the actors' group actions. In the present research, the model is used to answer the 1st research question.

A narrative is a concept that takes into account the teacher's motives and spontaneity by placing them within a time-space context (Mellone, 2011). Machalow and Goldsmith-Markey (2020) study the influence of former teaching experiences on teaching practice by creating a storyline for each teacher participant that consists of significant teaching events that they define as a narrative arc. In the present research, the narrative arc is used in shorter periods of time (the duration of the practice course) to create the teachers' CI developmental path through the practice course.

2.2 The context of the study

Nicolas, Anna, Eleutheria, and Katerina (gender-sensitive pseudonyms) were the 4 participants in the present study. They were undergraduate mathematics students who enrolled in a teaching practice course and had the chance to observe 2 online lessons and design and teach 2 other online lessons in grades 7, 8 and 9. They also attended an online university meeting once every 2 weeks where they learned about CIs and other theoretical concepts of didactics. The researcher accompanied the students during their virtual visits and right after class, he collected data by skype interviews . The course was held virtually due to the covid measures. In the interviews, the participants were asked if they had noticed something important during the virtual lesson and the researcher had the chance to analyze 15 CIs in total.

3. Results

3.1 What CIs did the prospective teachers attend? (RQ1)

It is concluded that CIs are mainly acted by the students, focused on mathematical thinking and the actions that happened within the incident's context are revealing the actor's cognition. One CI is acted by the students and is focused on the interactions between them. It belongs to the social subcategory. On table 1 is reported the CIs analysis.

3.1.1 The actor dimension

The critical incidents are acted by:

the teacher (T) e.g., Katerina's 1^{st} interview <and the teacher replied>.

the student (S) e.g., Eleutheria's 1^{st} interview <a student proposed the solution and…>.

or the students (Ss) e.g., Anna's 2^{nd} interview <the knowledge they had [the students] from>.

3.1.2 The dimension of the topic

The CI's topic was either *Mathematical notions* (M) or Teachers' *Teaching practice* (TP). Characteristic examples are:

On mathematical notion: slope, variables, linear function, geometrical solution, or permutations or relation between mathematical topics e.g Eleutheria's 2^{nd} CI was about a geometrical solution for a task that traditionally dealt with a very specific algebraic procedure <He [the student] translated the positive function to a strictly increasing function>.

Teachers' teaching practices: students' norms of participation, the task context, non-usage of the whole teaching material, students' vague answers, and use of specific teaching tools (e.g., a drawing bad).

3.1.3 The Teaching & Learning dimension

The analysis revealed 3 categories, the Cognitive (C), the Affective (A), and the Social (S)

Examples of the cognitive category: teacher provides a good example or representation, teacher or student explains, student's shift of thought, the teacher is posing rhetorical questions, referring to a specific student's difficulty. e.g., Katerina's 2^{nd} CI captured the teacher providing a good slope example in the class <he [the teacher] was showing that to move from point A to point B he did 9 steps to the right and 8 steps down>.

(A) affective: surprise.

(S) social: teamwork, e.g., Eleutheria's 2^{nd} CI revealed the students' teamwork < a student says … and another student answered …>.

3.2 How prospective teachers' attention is developed through their participation in a teaching practice undergraduate course? (RQ2)

During the practice course, the prospective teachers' attention moved from teachers to students and from teaching practices to mathematical thinking. Most CIs are about the actor's thinking (cognitive). For each CI a 3-dimensional list was created that informs us about the specific value the CI has on the actor, topic, and teaching & learning dimension. Each row of the matrix displays the narrative arc of a participant by displaying the CIs he attended chronologically.

Table 1: Teachers' Narrative Arcs

	1st interview	2nd interview	3rd interview	4th interview
Eleutheria	(S, TP, C)	(Ss, TP, S)	(S, TP, C)	(S, M, C)
Anna	(S, M, C)	(Ss, TP, C)	(T, TP, C)	(Ss, M, C)
Katerina	(T, M, C)	(T, M, C)	(Ss, M, A&C)	
Nicolas	(T, M, C)	(T, TP, C)	(S, M, C)	(Ss, M, C)

3.2.1 Nicola's narrative arc

On his first school visit, Nikolas turned his attention to a *teacher's actions* who created a cognitive aspect to his teaching by *providing a good explanation of his thinking*. This incident is about mathematics and, in particular, the *relationship between geometry and algebra* by stating that geometry can be used to define a more general context to a problem while algebra can provide exact results like plotting the route of a ship.

Table 2: Nikola's 1st school visit

Critical incident	They were doing algebra and then [the teacher] asked them what the relationship with geometry is, it was the perpendicular bisector I can't remember in detail. He shows it to them and calls somebody [on the board] to make a graph. The teacher tells them <ok, look geometry is more general and it gives us a mold, it gives us general rules and we herewith algebra are going to do exact and specific things> and then he refers to a specific example that a ship to calculate its route would have to use algebra.
Actor	Teacher (T)
Topic	The relation between geometry and algebra (M)
Teaching & Learning	Cognitive (C), the teacher provides an explanation

On his 2nd school visit, Nicolas observed a math class and he attended a *teacher*'s actions who used a *digital teaching tool* to provide a *good representation* of his thinking to the class.

Table 3: Nicola's 2nd school visit

Critical Incident	The teacher was drawing on a drawing pad and he wrote as if he was writing on a board.
Actor	Teacher (T)
Topic	The usage of digital teaching tools (TP)
Teaching & Learning	Provides a good representation (C)

On his 3rd school visit, Nicolas taught a mathematics class, and right after the lesson, he gave an interview where he stated his attention to a *student's* shift of *thinking* towards the correct usage of a *variable.*

Table 4: Nicola's 3rd school visit

Critical Incident	He [student] said this is n [variable] and he ended up providing a wrong answer. After having a conversation -where I was trying to make them understand about n- and what is going on the student ended up defining a correct n.
Actor	Student (S)
Topic	The notion of Variables (M)
Teaching & Learning	A shift of thought towards the answer (C)

On his 4th school visit, Nicolas taught a math class. During the interview after the lesson, he was interested in his students' answers. Nicolas attended to the students' shift of thought toward the concept of the *function x+3.*

Table 5: Nicola's 4th school visit

Critical Incident	A 3rd student said that there is a connection, there is a relation here x+3 and so they created [the students] all the ingredients of a function by themselves.
Actor	Students (Ss)
Topic	The linear function (M)
Teaching & Learning	A shift in students' thinking (C)

4. Conclusion

Prospective teachers are initially focused on the teacher who exhibits his thought in his effort to transfer knowledge to his students and finally they focus on students and their effort to construct mathematical meanings.

The teaching & learning dimension of the Rotem and Ayalon (2022) CI model allowed greater access to teaching by taking into account teaching and learning practices and some basic linkage between CIs and the broader learning theories. Machalow and Goldsmith-Markey (2020) narrative arc concept supported the creation of a broader picture of the prospective teachers' development. The narrative arc is suitable for revealing shifts in teaching like in the analyses of Nicola's narrative arc. Initially, Nicolas attended CIs that are acted by the teacher who exhibits his thoughts to his students. Such incidents are consistent with the Greek traditional teaching culture where the teacher who possesses the perfect knowledge transfers it to his students. Such practice is described by Mason as teaching lust (Souralis, 2022). Later on, Nicola's teaching practice shifted from teaching lust to a constructivism paradigm when he attended to a student's thoughts (Goodell, 2006).

5. Discussion

Noticing and critical incidents are important issues in didactics of mathematics and only a small portion of the relative literature has been studied. Almost every CI attended by the prospective teachers is cognitive. The lack of social CIs could be an issue to be addressed by feature research. The undergraduate course has a positive effect on teachers' development according to previous research results (Amador & Carter, 2018; Crespo, 2000; Van Es & Sherin, 2002). Limitations of the study are that it was conducted almost entirely online due to the covid restrictions.

6. References

Amador, J. M., & Carter, I. S. (2018). Audible conversational affordances and constraints of verbalizing professional noticing during prospective teacher lesson study. Journal of Mathematics Teacher Education, 21(1), 5-34.

Callejo, M. L., & Zapatera, A. (2017). Prospective primary teachers' noticing of students' understanding of pattern generalization. Journal of Mathematics Teacher Education, 20(4), 309- 333.

Crespo, S. (2000). Seeing more than right and wrong answers: Prospective teachers' interpretations of students' mathematical work. Journal of Mathematics Teacher Education, 3(2), 155-181.

Goodell, J. E. (2006). Using critical incident reflections: A self-study as a mathematics teacher educator. Journal of Mathematics Teacher Education, 9(3), 221-248.

Jacobs, V. R., Lamb, L. L., & Philipp, R. A. (2010). Professional noticing of children's mathematical thinking. Journal for research in mathematics education, 169-202.

Mason, J., & Spence, M. (1999). Beyond mere knowledge of mathematics: The importance of knowing-to act at the moment. In Forms of mathematical knowledge (pp. 135-161). Springer, Dordrecht.

Machalow, R., Goldsmith-Markey, L. T., & Remillard, J. T. (2020). Critical moments: pre-service mathematics teachers' narrative arcs and mathematical orientations over 20 years. Journal of Mathematics Teacher Education, 1-27.

Mellone, M. (2011). The influence of theoretical tools on teachers' orientation to notice and classroom practice: a case study. Journal of Mathematics Teacher Education, 14(4), 269-284.

Potari, D., & Psycharis, G. (2018). Prospective mathematics teacher argumentation while interpreting classroom incidents. In Educating prospective secondary mathematics teachers (pp. 169-187). Springer, Cham.

Rotem, S. H., & Ayalon, M. (2022). Building a model for characterizing critical events: Noticing classroom situations using multiple dimensions. The Journal of Mathematical Behaviour, 66, 100947.

Skott, J. (2001). The emerging practices of a novice teacher: The roles of his school mathematics images. Journal of mathematics teacher education, 4(1), 3-28.

Star, J. R., & Strickland, S. K. (2008). Learning to observe: Using video to improve preservice mathematics teachers' ability to notice. Journal of mathematics teacher education, 11(2), 107-125.

Taylan, R. D. (2017). Characterizing a highly accomplished teacher noticing of third-grade students' mathematical thinking. Journal of Mathematics Teacher Education, 20(3), 259-280.

Van Es, E. A., Hand, V., & Mercado, J. (2017). Making visible the relationship between teachers' noticing for equity and equitable teaching practice. In Teacher noticing: Bridging and broadening perspectives, contexts, and frameworks (pp. 251-270). Springer, Cham.

Van Es, E. A., & Sherin, M. (2006). How different video club designs support teachers in ''learning to notice''. *Journal of Computing in Teacher Education*, 22(4), 125–135.

Van Es, E. A., & Sherin, M. G. (2002). Learning to notice: Scaffolding new teachers' interpretations of classroom interactions. *Journal of Technology and Teacher Education,* 10(4), 571–596.

Warshauer, H. K., Starkey, C., Herrera, C. A., & Smith, S. (2019). Developing prospective teachers' noticing and notions of productive struggle with video analysis in a mathematics content course. Journal of Mathematics Teacher Education, 1-33.

Souralis, C (2022). How the prospective teachers interpret the critical incidents within the context of their first experiences in a school classroom. In: C. Stathopoulou, T. Triantafillidis, K. Chatzikiriakou, A. Chronaki, & B. Chrisikou (Ed). *Proceedings of the 9th Panhellenic Conference of ENEDIM: Mathematics education facing the old challenges and the new.* Volos, ENEDIM [In Greek].

.

Evaluating digital educational tools

Kleopatra Kalogerakou , ckalogerakou@hotmail.com

1st Model Junior High School of Athens

Abstract

In this paper, features and uses of certain digital tools will be explored and evaluated in the context of CONNECT educational scenarios. The added value of these tools in the learning process will be discussed. Finally, new possibilities and innovative ways of using various digital tools will be introduced as examples of good educational practice.

Keywords: digital tools, collaboration, communication, creativity, critical thinking, multimodality

1. Introduction

1.1 Digital technology in the learning process

Digital technology has become indispensable in the learning process nowadays. Educational practices should adapt to the needs of a student population who, as digital natives, prefer learning through technology to conventional ways of learning (Golonka et al, 2014). Digital tools surely affect teaching and learning and their added value is beyond any doubt when they are implemented in accordance with the teacher's goals and the learner's needs. Their pedagogical integration can enhance key competences such as critical thinking, creativity, collaboration and communication. Engagement, representation, action and expression are essential elements for transforming the educational process. Motivation equals engagement and digital tools have the potential to engage learners more in the learning process. Multiple means of representation cater for the diversity of students with different learning styles and different pace of learning. By following their own way of learning, students become autonomous learners and can demonstrate acquisition of skills and knowledge.

1.2 Skills in Web 2.0 spaces

Collaboration is promoted in all scenarios as part of the learning process. Various digital tools are used to enhance collaboration. Such collaborative tools encompass all of Bloom's learning stages. According to Bloom's Taxonomy, on the Cognitive Dimension (Krathwohl, 2002), learners work both on lower-order skills – recalling information, interpreting and comparing content, putting new knowledge into practice – and higher-order skills – breaking down concepts into manageable chunks, analyzing newly acquired knowledge and creating something new.

In Web 2.0 spaces, learners learn how to co-create multimodal content and express their opinions and attitudes, becoming, thus, active participants in the learning process. Their learning becomes purposeful and self-directed by applying their existing knowledge to make new meanings and connections (Barton, D. & Lee, C., 2013).

Approach

2.1 Blended Learning and Flipped Classroom

All CONNECT scenarios are based on the models of Blended Learning and Flipped Classroom. There are three distinct phases, starting with asynchronous presentation and tasks, followed by a synchronous phase, in which learners expand on the knowledge they have gained from the asynchronous phase and finishing with an asynchronous phase, in which they consolidate knowledge as well as create and evaluate their work. Each phase in the scenarios has its own objective and learning outcomes and promotes transversal skills and competences required for 21st century students. If technology is meaningfully-integrated in the learning process, learning environments become more accessible to diverse learners (Eymenova, A. 2018). CONNECT scenarios, by combining traditional face-to-face instruction with technology-mediated instruction, promote blended learning which involves different modes of instruction and accommodates different learning styles. In this way, learners have more opportunities to collaborate in real time and at a distance, thus, offering more opportunities for interaction. Learning activities are added to enhance learning while flexibility plays an important role in time management. Digital technologies are at the heart of such an approach. The learner becomes a knowledge actor and not simply a recipient of knowledge by fabricating, recording and communicating meaning (Kalantzis, M. & Cope, B. 2011). Learners develop their digital skills, something which leads to their becoming more responsible virtual citizens.

2.2 E-learning platforms

In all CONNECT scenarios, e-learning platforms are used as part of flipped classroom practice and blended learning. Whether e-me in Greece, Google Meet in Italy or Teams in Cyprus, these virtual classrooms facilitate distance learning. Learners are able to interact with teachers and peers through chat rooms, file sharing and a range of additional tools. E-learning platforms allow for great flexibility and customization of the teaching/learning process, which can be modified and adapted to learners' needs and pace of learning. A social platform, such as e-me, provided by the Greek Ministry of Education as an asynchronous education platform for Greek schools, incorporates social networking features and it is a safe space where students can communicate, share and collaborate with their peers within the school community (Mitsikopoulou, B. 2020). Assessment and feedback are incorporated as important aspects, which together with time management, can offer a complete learning experience.

Results

3.1 Use of G suite

CONNECT scenarios make use of the Google suite to create online word processing documents (presentations, spreadsheets, documents, and so on), providing, thus, learners with the opportunity to have group access and co-edit/co-create material. This distinctive feature promotes teamwork and collaboration among students. In addition, it allows teachers to keep track of learners' progress and contribution, and provide feedback as a means of formative assessment, while learners take responsibility for their own learning by self-correcting and giving peer feedback. Google forms are also used as a means of activating prior knowledge and self-assessment in the form of questionnaires.

A text editor, like google docs, places more emphasis on process writing, as opposed to traditional product-oriented writing process, something which contributes significantly to the way learners think when writing but also to improvement of writing skills. Moreover, when writing is collaborative, there is the added value of sharing, contributing and peer-assessment in a non-threatening environment. At the same time, teachers can monitor learners' progress and guide them through comments in a non-judgmental way and identify their weaknesses.

3.2 Web 2.0 tools

Apart from the Google suite, other collaborative tools found in the scenarios are blogs and wikis, which further encourage learners to take control of their learning, promoting, thus, autonomous learning. Being exposed to but also creating and maintaining a blog or a wiki, apart from motivation and interaction, learners are encouraged to use quality content on the Internet, develop critical thinking skills. Learners can become dynamic thinkers in exploring and interacting with the Web (Gilster, P. 1997) when content is meaningful and purposeful.

Creating word clouds is a prevalent element in teaching a foreign language but other content areas as well. Word clouds are ideal for visual learners who are usually overwhelmed by dense texts and need to decode language. In a word cloud, important words and key phrases are highlighted, reducing, thus, cognitive load. Student-created word clouds, apart from being a powerful formative tool, can also facilitate class discussions and help learners retain and recall information more easily.

In addition to word clouds, online dictionaries contain visual content which is more attractive and generates interest among learners. It helps learners understand key words and concepts and is a tool that, if often used, can lead to independent learning.

Other effective educational practices through digital tools used in the scenarios are infographics and online posters. Infographics is another way of breaking down information into manageable chunks for learners to understand. An online poster helps create visually appealing content. Both infographics and posters allow for various features to be included, such as videos, photos, text and so on, thus, simplifying, highlighting and explaining text-based information. By using the appropriate digital tool, learners can share and collaborate on the same design.

Timelines are also a useful digital tool which helps make connections and present events in chronological order. Although it is most commonly used to present historical events, it can be used in any subject area to arrange events. Conceptual maps work in a similar way. Maps help learners better understand, process and recall information by seeing the relationship between concepts in an engaging visual way.

In the case of Math, Geogebra is widely used to conceptualize knowledge. It is a powerful tool which allows for not only visualization but also manipulation of data and can enhance Math instruction. It can also be a tool for formative or summative assessment since learners' answers are recorded.

Discussion

All CONNECT scenarios take into consideration the three key concepts in the learning process: the 'why', 'what' and 'how' of learning following the Universal Design for Learning (CAST, 2017), that is, multiple means of engagement, representation and action/expression. For example, in the scenario 'Homeschooling', a topic of interest, is explored in such a way as to motivate learners to learn more about education, discuss, argue and critically approach the issue of education and the role of school (the 'why' of learning). The teacher also uses different means of presenting content and information. In the asynchronous phase, the teacher uses the e-me platform to present material through multimodal texts, webpages, dictionaries, corpora, videos (the 'what' of learning). Finally, the teacher provides learners with different options to participate and interact through fora, blogs, chat but also interactive activities to consolidate knowledge, such as drill and practice activities by using either e-me embedded tools or external tools. In the synchronous phase, learners are involved in real life tasks such as discussions in which they present their views, prepare questionnaires for their peers (the 'how' of learning), all of which contribute to developing metacognitive skills (learning-how-to-learn) and adopting a critical approach to the issue at hand.

It is of great importance that the scenarios build on learners' prior knowledge as a scaffolding technique aiming at reducing cognitive load. The teacher should motivate learners to try and incorporate new meanings into their prior knowledge instead of simply memorizing concepts. Learners are able to build on their schemata in order to acquire new knowledge. An indicative example can be seen in the scenario 'Graffiti and Street Art', in which the teacher has created an online questionnaire on the e-me platform, the answers to which can be discussed, challenged and revised after being introduced to the topic.

The use of the Internet and custom-made videos, which support personalized learning experience and offer space for reflexivity, is a prevailing feature in the scenarios. Some indicative examples are provided below:

In the scenario 'To connect or not to connect', which deals with the topic of human relationships, the teacher shows a short film featuring changes in educational settings, an innovative means or presentation to capture learners' attention, inspire them and deepen their understanding of the topic.

In the scenario 'Graffiti and Street Art', which deals with an interesting and popular form of art with adolescents, learners are presented with an interesting TedEd video on the history of graffiti. They also take a virtual tour of street art in their own city and, in pairs, they discuss and create a visual representation of the information in the form of relationships. In this way, they convert information from one text type into another one developing their critical thinking, divergent and convergent thinking, as stated in the objectives of the scenario.

In Math, the scenarios 'Identities' and 'Linear system of two equations', make use of custom-made interactive videos, which learners watch to understand and answer questions that appear at different parts of the video, so that they can understand the concepts at hand.

In Physics, in the scenario about 'Refraction', in the asynchronous phase, the teacher has chosen to create his own video explaining how refraction works using simple items in order to engage learners and help them understand the phenomenon in real life.

There is a wide range of Web 2.0 tools used in the scenarios to provide and test knowledge. There is widespread use of H5P activity types in the scenarios, mostly as part of the e-me platform, which such tools are embedded on and which allow teachers to create engaging learning activities such as quizzes, drag and drop activities, open-ended questions and many more visual activities. Apart from H5P, there are a number of other external tools used, such as Geogebra learning apps, genially, quizlet and a lot more. Some indicative examples are provided below:

We can see uses of H5P comprehension M/C activities in the scenario 'Graffiti and Street Art' after watching a video. Examples of external tools used in the scenarios involve, among others, the use of a quizlet to introduce and practice terms in the scenario 'Volcanoes', a knowledge quiz in the scenario 'Introduction to Electricity' or an interactive quiz in 'Introduction to polynomial'. Geogebra, an application of practical use in math education, is also used to make abstract concepts more meaningful by visualizing them and experimenting with them. Examples can be seen in the scenario 'The Pythagorean Theorem' and in 'Types of Triangles'.

Apart from Geogebra, which is an effective simulation tool in Science, real world experience can be provided through online simulations so that learners can interact and experiment with the content and be able to understand difficult concepts in science learning. An indicative example of such a simulation tool can be found in the Physics scenario 'Introduction to Electricity'.

Games add an element of fun to the learning process whether this is language, math, or science. A live quiz activity about electricity can help learners consolidate knowledge in a fun way. Practicing language through kahoot, learners become more engaged and motivated. Revising the Pythagorean theorem in an escape room is an excellent way of interacting with and simulating content and reflects good teaching practice.

Assessment constitutes an indispensable part of the scenarios. The types of assessment vary from self-assessment to peer-assessment and from formative to summative assessment, each one having their own added value. Self-assessment helps learners evaluate the knowledge they have gained in a non-judgmental way, critically reflect on their own learning, identify their weaknesses and become responsible for their learning. The digital tools used for self-assessment include Google forms or questionnaires in the virtual classrooms. Indicative examples can be seen in the scenario 'Identities'. Formative assessment is prevalent in the scenarios through various digital tools, either on the G suite or by using activity types such as 'drag and drop'. An indicative example of summative assessment to check understanding of a math concept can be found in 'Linear system of two equations'.

Conclusion

Learning through authentic learning material and activities as well as through personal involvement helps cognition and is a key feature of constructivism. Interactive learning environments lead to cognition and interaction. Through interaction and scaffolding techniques, following the 'social constructivist approach' to learning (Vygotsky, 1978), learners are encouraged to compensate for their weaknesses and be active instead of passive learners.

References

Barton, D. & Lee, C. (2013) *Language Online: Investigating Digital Texts and Practices.* London, UK: Routledge

CAST: Center for Applied Special Technology (2017). What is the universal design for learning? https://www.cast.org/impact/universal-design-for-learning-udl accessed November 2, 2022

Evmenova, A. (2018). Preparing Teachers to Use Universal Design for Learning to Support Diverse Learners. *Journal of Online Learning Research, 4*(2), 147-171. Waynesville, NC USA: Association for the Advancement of Computing in Education (AACE). .https://www.learntechlib.org/primary/p/181969/ accesses November 2, 2022

Gilster, P., & Glister, P. (1997). *Digital literacy*. New York: Wiley Computer Pub.

Golonka, E.M., Bowles, A.R., Frank, V.M., Richardson, D.L., Freynik, S., (2014). Technologies for foreign language learning: A review of technology types and their effectiveness. *Computer Assisted Language Learning* 27, 70–105

Kalantzis, Mary and Bill Cope. 2011. "The Work of Writing in the Age of Its Digital Reproducibility." in *Rethinking Identity and Literacy Education in the 21st Century*, vol. 110: 1, edited by S. S. Abrams and J. Rowsell. New York: Teachers College Press.

Krathwohl, D. (2002). 'A Revision of Bloom's Taxonomy: An Overview'. Theory into practice, 41: 212-264

McCormick, R. (2004). Collaboration: The challenge of ICT. *International Journal of Technology and Design Education,* 14(2).

Mitsikopoulou, Bessie. (2020). Multimodal and digital literacies in the English classroom: interactive textbooks, open educational resources and a social platform. In book: Multiliteracy Advances and Multimodal Challenges in ELT Environments (pp.97-110). FORUM Editrice

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. In M. Cole, V, John-Steiner, S. Scribner, & E. Snuberman (Eds.). Cambridge, MA: Warvard University Press.

Reflections on the teaching of English through the use of the Flipped Classroom technique

Georgia Gyftoula , georgyftoula@enl.uoa.gr

English teacher, Ph.D.c., National and Kapodistrian University of Athens

Abstract

The article addresses Foreign Language teachers primarily and it draws from the experience gained through the review process of educational scenarios created within the framework of CONNECT Erasmus+ project implemented by the Regional Directorate of Primary and Secondary Education of Attica, Greece. However, the information and suggestions included in it may equally fall in the interest scope of all teachers regardless of their specialty. The discussion entails the definition of the technique in question followed by a short description of the context and important factors which affect its implementation in foreign language classrooms today. The article is meant to focus on the underpinning philosophy and principles the technique follows with a special focus on the teacher and learners roles as well as the potential of the digital educational material in use. The results of the educational scenarios review will be documented by extracts of the activities included in them. Finally, suggestions will be made for more efficient implementation of the technique based on this content while eliciting the readers' reflective comments will be pursued.

Keywords: blended learning, Flipped Classroom technique, teacher and student roles, educational scenarios, critical learning incidents, digital platforms

1. Introduction

The Flipped Classroom technique has been on air for quite some time now and it seems that teachers around the globe have embraced it more closely after the experience the Covid-19 pandemic endowed both teachers and learners with. Combining the distance and face-to-face teaching of a subject depends on digital media, tools and platforms available and the idea of flipping the teaching practice and inviting learners to follow a different learning path has a certain appeal to the education world. This discussion has been generated by the findings and thoughts triggered during the reviewing process of educational scenarios for the teaching of the English language designed by educators in Cyprus, Italy and Greece and the emphasis put on detecting the critical learning incidents which were potentially favored by their design.

Putting aside the peculiarities of each individual educational context and meaning to target a more general audience, the content of this work aspires to provide with relevant knowledge and experience all teachers of practice without any limitations imposed by the subject they are currently teaching, the educational system they serve in, the diverse curricula and school contexts. It is assumed that whatever comes out of this reflective discussion and revolves around the extracts of the educational scenarios under review may be considered as a useful initiator of a more personalized query for more efficient teaching practices. Moreover, part of this work revolves around the definition and value of the critical learning incidents, the teacher and learner roles, the educational material used and the factors which impact on the integration of this technique. As a consequence, the reader of this work will hopefully find answers to questions like: What does this technique entail? Which factors facilitate or hinder its integration? What is the critical opportunity of the present which may pave the way for a more frequent exploitation in the future? How does this technique stress the critical learning incidents and support teachers' efforts to help their students take full advantage of them?

Making connections to one's own context and transferring the situation described to one's own teaching routine is highly recommended while reading this work. Doing so might lead to decisions relating to changing parts of one's own teaching practice to the benefit of more learner-centered approaches or even adopting this way of teaching with a view to evaluating both its impact on the learning outcomes and the qualities of their teaching profile.

1.1 The teaching context following a critical event

Following a period of disruptions and changes in many aspects of human activities, education stakeholders are currently trying to evaluate the situation and estimate the shifts the future holds for them, their students and the ways they both interact. Now that the dust of a very critical global event has settled, people in the teaching trade take their time to understand whether the shift to online teaching and the new methods of class delivery are here to stay for good. What at the beginning of this horrid adventure seemed to be a major scale challenge for education systems and their main actors has proved to turn into valuable insights and a unique opportunity. Without any doubt, teachers have suffered a time of extreme burn-out while learners came to appreciate their efforts and time spent together in the classroom. Moreover, parents' fear of having youngsters stay lazy at home and losing touch with their normality (Egan et al., 2021) paired with the thought that allowing children to choose their own paths into learning and content might inspire deeper understanding and appreciation of the schooling period in their life. This very sense of the great significance the teacher-learner and learner-learner interactions bear has promoted every idea which enables teachers and learners to make the most of their time at school. Furthermore, the necessity to be adaptable and resourceful, the urge to provide learners with opportunities for constant contact and deeper understanding of content even if physical presence is inhibited and the realization that digital technologies constitute an undoubtedly powerful ally have prepared the ground for different teaching techniques which were not previously put into practice.

According to post-pandemic literature (Zhao & Watterston, 2021:3), there are three major changes which should define post-COVID era in teaching: "…*the curriculum that is developmental, personalized, and evolving; pedagogy that is student-centered, inquiry-based, authentic, and purposeful; and delivery of instruction that capitalizes on the strengths of both synchronous and asynchronous learning*". Many other resources confirm an unprecedented shift to innovation (Kamanetz, 2020; Sun et al., 2020; United Nations, 2020) and the potential for an en masse change in teachers' ways of teaching and learners' ways of learning. Moreover, responding to the demand for more learner-centered classes and more actively-engaged students (Tomlinson, 2014; Tucker, 2020) so that new knowledge and skills are mastered, techniques like that of the Flipped Classroom have come to the foreground. In the following section we will define the characteristics and attempt to distinguish the benefits which this technique may bring to the learning process.

1.2 The Flipped Classroom technique

The idea of blended learning (Bishop & Verleger, 2013) has been promoted as a very effective model of teaching as it combines face-to-face and distance learning. Especially after Covid-19 period and due to the realization that the physical contact of teacher and learner is highly valued and desired and that perhaps a combination of both online and face-to-face learning opportunities could prove more efficient, blended learning comes to refer to a mixture of online and onsite learning environment in analogies which fully exploit the digital technologies potential yet they value the teacher-learner interaction. Apart from the fact that teachers and students were originally forced to move online and the choice of digital media as the channel of communication was an imposed and not fully-informed choice at the very beginning, the call for student-centered, inquiry-based, authentic, and purposeful modes of delivery justify the prediction that blended learning methods may hold the secret to a more balanced combination of learning modes which is here to stay. According to the blended learning principles (Chen & Jones, 2007; Friesen, 2012; Valiathan, 2002), the teacher distances themselves from the traditional delivery of new knowledge inside the classroom but instead provides the learner with the new content via digital channels.

Based on the blended learning method, the Flipped Classroom technique found its way into the teaching world helped by the methodological suggestions of Eric Mazur (1997) which introduced the idea of peer teaching and the initiative of Wesley Baker (2000) to introduce online-based learning and defend the benefits that may arise from the use of digital technologies. Later, two American scientists Aaron Sams and Jonathan Bergman record their lectures and deliver the videos to students who could not attend their classes (Noonoo, 2012). According to literature, the Flipped classroom is the term commonly defined as a pedagogical technique in which traditional lecture and homework study are reversed (Hamden et al, 2013; Lage et al, 2000) as learners come into contact with new knowledge before they enter the classroom so that the time they have with their teacher in it is devoted to reflection time, problem-solving, inquiry-based and collaborative learning tasks.

The principle of prioritizing active learning inside the classroom while the core material for study is assigned to be studied at home is fundamental in the Flipped Classroom technique which foresees three different phases of implementation: the pre-, in- and post-classroom phase.

More explicitly, after the teacher has defined the learning outcomes they want their learners to achieve (see Fig.1), they develop the material they will assign for study at home. The material may comprise short videos, multimodal texts and resources such as links to websites.

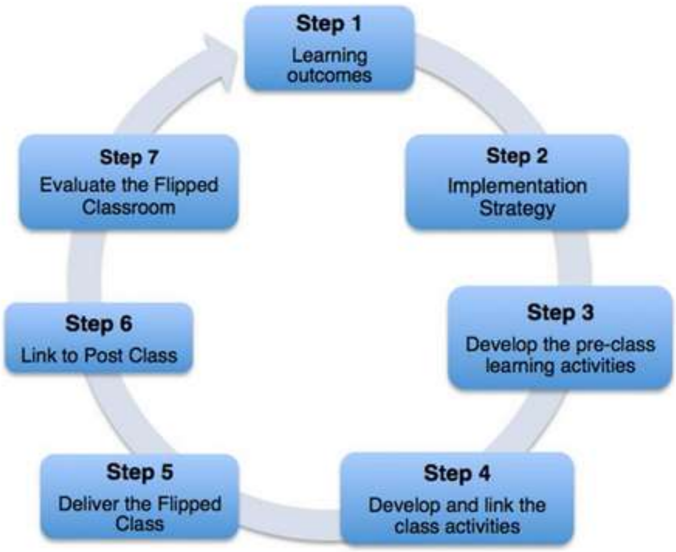


Figure 1: The preparation steps for the flipped class delivery (Karanicolas, S., Snelling C., and Winning, T., 2015)

The learners are invited to access this material usually through the digital environment of an e-class, study it at their own pace, record areas which need clarification and work on tasks which promote deep understanding. All this equals the traditional lecture content offered through a digital channel yet it allows learners more time for study and reflection. When they come to the classroom they have more time to engage in problems, experiential learning and inquiry-based tasks and meaningful interaction with their peers. They collaborate, test hypotheses, read critically, exchange and present their work in plenary. The third phase of the technique is connected to homework assignment and requests the learners' commitment so as they consolidate or reshape knowledge by adding their personal imprint. This is also the time for evaluation of the whole procedure and self-assessment.

The three phases above would be meaningless unless they were part of a well-designed learning scenario. According to relevant literature (Errington, 2005; Kalantzis & Cope, 2010), designing the steps of presenting learners with new knowledge makes it easier for teachers to match the objectives they set to the most appropriate content and assign both themselves and their learners with new roles.

2. Approach

2.1 The review process: focusing on critical learning incidents

As previously stated, this article focuses on the review of eight learning scenarios which were designed by teachers of English as a foreign language within the framework of a European project[1]. The project promotes the idea of online education through the use of the Flipped

[1] CONNECT – Upskilling of sChools' teachers to effectively support ONliNe EduCaTion is an Erasmus+KA2 project which brings together **schools** from **Greece, Italy and Cyprus and it is** meant to reinforce the ability of EU secondary schools to provide high quality and inclusive online education. The project consortium includes the Regional Directorate for Primary and Secondary Education of Attica (RDPSEA) and the Computer Technology Institute and Press "Diophantus" in Greece, the Institute for Educational Technology (CNR-ITD) in Italy, and the University of Cyprus (UCY) https://connect-erasmusproject.eu/index.php/en/

Classroom technique. The learning scenarios were developed by EFL teachers in low secondary schools in partner countries. The authors were provided with detailed instructions and they were advised about the duration of the phases, the principles of design and the utilization of digital tools in a way which will prove that the idea of critical learning incidents has been taken into consideration. Before moving to the learning scenarios under review, defining and understanding the term "critical learning incidents" will support the reader's effort to gain deeper insight in the way the Flipped Classroom technique acquires more meaning.

According to Soini (2012), critical learning incidents are learning situations which "…*learners have experienced as effective, exceptional, or personally meaningful*" and they can "… *lead to educationally significant learning and personal growth*". As it is the case with most terms used in educational literature, its origin lies in a different field. In this case, John C. Flanagan, a psychologist developed the critical incident technique (CIT) during World War II in his effort to understand why airplanes crash. He describes CIT as "…*any activity that is sufficiently complete in itself to permit predictions to be made about the person performing the act*" (Flanagan, 1954: 335). Much later, other researchers (Tripp, 1993; Thiel, 1999; Farrell, 2008) investigated and suggested structured frameworks for analyzing critical incidents all of which recognized the contribution of reflective thinking to the development of learning strategies. Finch (2010) discusses these ideas from the perspective of language learners recognizing that learning is a complex, multi-level and ever-evolving process which might be interrupted, slowed down or accelerated by various factors. Taking all the above into consideration, the review of the aforementioned learning scenarios was based on a number of questions which helped the reviewer estimate the outcome. Therefore, the reviewer's main goal was to spot the scenario's potential to provide learners with opportunities for full engagement, discussion and fruitful exchange, surprising and motivating information or rewarding experiences while on the other hand to minimize boring, non-interactive or confusing activities. In a nutshell and during the review process, the author of this article and reviewer of the learning scenarios was engaged in a conversation with self which developed around the following questions: a. Which are the positive/negative/interesting points of this scenario? b. Are there alternatives mentioned? c. Why is this activity here? What purpose does it serve? Does the use of a specific digital tool really make a difference for the learning process? d. What if something else was in its place? Could this activity fit better in another phase of the flipped class? Would that be more appropriate and beneficial?

Knowing that effective learning passes through meaningful and enjoyable experiences and tasks which avoid getting learners feel intimidated or unwilling to try, the intention was to read through these scenarios and detect the areas which either followed or ignored this conviction. The ultimate goal remained to spot examples of good practice but more importantly reflect on instances which needed improvement and indicate those ones as a reflection trigger point for professional development and growth.

2.2 An overview of the educational scenarios

The educational scenarios under review were developed with a view to promoting digital media use in three different school subjects: Maths, Science and English. The age range of the target student group was 13-15 which practically means students in low Secondary. As the scenarios were designed following the Flipped Classroom technique, each one comprised two phases for asynchronous and one phase of synchronous teaching sessions. The duration of each phase varied however the instructions advised for 60΄- 120΄ in total for the asynchronous sessions and 60΄- 180΄ in total for the face-to-face session. All scenarios were developed in English and they would be translated in Greek and Italian at a later stage. Scenario developers had to make use of a certain template and follow a specific structure and guidelines which urged for three distinct but interrelated phases (before-during-after). Blended learning method, the Flipped Classroom technique and the use of a platform which could support asynchronous learning were the three methodological principles to be attended.

The developers were also advised to confront the educational scenario as the evolution of a lesson plan, a form of "theatrical" and "didactic" act. The scenarios also evolved around the basic principles and concepts adopted in the field of cognitive and socio-cognitive theories, based on the social constructivist model (Schreiber & Valle, 2013), which viewed learning as a "a collective process of social and cultural interaction as well as participation in collaborative learning and practice communities"[2]. Finally, the teachers were advised to take certain qualities into consideration and create scenarios which would exploit learners' prior knowledge and experiences (promote experiential learning), connect new knowledge to real life, place emphasis on inquiry-based and differentiated learning, provide learners with opportunities for "collaborative action" through authentic learning experiences and adopt alternative forms of assessment regarding the learning process. An overview of the scenarios developed can be seen in Table 1 below.

Table 1: An overview of the scenarios content

	Title	Topic	Target age group	Language level	Time allocation	Digital Media
1	To connect or not to connect?	Human Relationships	14-15	B1+	30΄-45΄-60΄	Platforms such as e-class, e-me, Canva, WordArt
2	Graffiti and Street Art: Controversial Artistic Expression	Art (Graffiti and Street Art)	14-15	B1+	45΄-90΄-45΄	Platforms such as e-me, e-class and parkAdobe, Sutori, BeFunky MindMup
3	Sports, Hobbies and Leisure	Sports, Hobbies and Leisure	13-14	A2	30΄-60΄-45΄	Google Meet, Google Forms, Genially
4	Present Perfect: Presentation	Present Perfect	13-14	A2	45΄-60΄-45΄	Google Meet platform, Google Forms

[2] The descriptions are extracted from the "Instructions for Developing Educational Scenarios" manual which was produced within the framework of this project.

5	Summer Plans	Summer plans	13-14	A2	30΄-55΄-90΄	Microsoft Teams Platform
6	Camping, to the future	Camping	14-15	B1	45΄-80΄-45΄	Microsoft Teams platform, PowerPoint presentation with links to interactive exercises, Quizizz, Flipgrid, Framapad
7	Are conditionals associated with bad luck?	Superstitions	14-15	B1	45΄-80΄-45΄	Microsoft Teams platform, PowerPoint presentation with links to interactive exercises, Canva, Flipgrid
8	Phobias	Phobias	14-15	B1	45΄-90΄-60΄	Teams platform, PowerPoint, Wordwall, Quizlet, Canva, WordArt,

3. Results

3.1 Factors to take into consideration: actors' roles, opportunities and the digital world

The educational scenarios review was based on a list of distinct criteria and the requirements set and provided to the teachers beforehand. A number of differences attributed to the teaching contexts and their qualities were immediately evident and were connected to the language level, the digital tools and platforms used. All scenarios followed the design principles and guidelines given. The topics chosen were appealing to the target age group and were meant to initiate motivating discussions with equally interesting extensions. The scenarios addressed students of low Secondary Education and made use of a platform for asynchronous learning and popular digital tools. As for the time allocated to the three phases, it abided by the time frame given.

In relation to the general criteria given, all scenarios made use of simple and clear language and the content description followed a coherent development rationale. In terms of the aim and objectives, there were some cases where the aim of the scenario was expressed in ways more fit for the objectives description and vice versa. In terms of time allocation to the activities, some few cases where the activities should be allowed a wider time span were spotted, e.g. creating an infographic with the use of a digital tool should probably take more than that allocated. Moreover, a smoother transition from one activity to the other which could lead to better results was occasionally in need. Finally, the activities designed promised some kind of engagement in complex processes, critical thinking and life skills development. Yet, experiential learning could be more emphasized at times, e.g. teaching the Present Perfect tense could be achieved implicitly and in a more enjoyable manner through the implementation of a collaborative activity like that of creating short paragraphs with the students' life achievements and experiences for the class yearbook.

Tending to believe that the reader of this article will benefit more from observations related to the critical learning incidents and the factors which weaken or boost the scenario's impact, a discussion of the *roles* assigned to the main actors, the frequency and quality of *learning opportunities* and the appropriate *integration of digital media* is suggested. Going back to the questions asked and in order to reflect efficiently on the choices the scenario developer made, putting oneself in the shoes of the teacher who might want to implement the scenario in their own context is strongly recommended. In this article, it is argued that making proposals on the basis of the observations and critical evaluation of the Flipped Classroom technique may benefit the reader more. After all, the model which is followed here calls for a complete inversion of a traditional learning experience. As a consequence the roles the teacher and students undertake diverge and they are expected to assert a significant impact on the learning experience offered. Less guided forms of interaction, more interactive and collaborative use of digital technologies is expected and a clear shift to energetic participation in all activities is pursued, even in those which are assigned at home. These three very important factors determined the choice of scenario extracts and they will be the focus of our discussion below.

4. Discussion

The role of the teacher and student

Title of educational scenario PHOBIAS (During Phase B Synchronous) The students are presented with a picture of "Agoraphobia". Teacher asks questions and Ss provide guesses and hints on the kind of phobia and the related feelings.

Away from the teacher model of the past and walking towards indirect instruction, the Flipped Classroom technique attracts the attention of the teacher who does not provide new knowledge but rather expects the learner to discover it. Therefore, the teacher observes the development of the class, recognizes the points which might instigate fruitful discussion and meaningful inquiry and drives their students there by making the right kind of questions Johnson & Renner, 2012). According to Bergmann & Sams (2014), it is the teacher's responsibility to create learning conditions based on questioning. Adding to the list of teachers' new roles we can also mention the frequent interactions with the students, the creation of interactive conditions so that all students participate actively and the necessity to reshape this interaction in the individual form according to the student's needs (Cohen & Brugar, 2013). Moreover, the selection of the appropriate digital media and their fine tuning to the purpose teachers want them to serve seems to be very crucial (Fulton, 2012).

(During Phase C Asynchronous) The teacher makes a statement about "xenoglossophobia" and poses a question in the forum of the platform.

The students choose how they would like to answer the questions

i) write a blog

ii) create a digital poster and/or

iii) an infographic

In line with the context created by the teacher, the students are invited to make their own well-informed choices and take the responsibility of an assignment, develop collaboratively and share the outcome with their classmates, ask for clarifications and receive them along with feedback from peers and their teacher (Tucker, 2020). Furthermore, the asynchronous phases of the model present students with the opportunity to take the time and reflect on their choices, work at their own pace and experiment with new technological means.

Catering for meaningful learning opportunities

Title of educational scenario: PRESENT PERFECT PRESENTATION

(During Phase C Asynchronous) The teacher will provide a list of irregular verbs to help students recall them

The teacher will provide a quiz about the present perfect. It will cover all the topics discussed.

Implementing the Flipped Classroom model means a firm decision to abandon old habits. Providing the students with lists of grammar rules does not take any weight off our shoulders, ease our worries about what they do with English at home or pay off in advance their commitment to study grammar. Everything we do should be done for a purpose and be part of our planning. In the extract above, learners are invited to study a list of irregular verbs and do a quiz. Could the teacher trust they do the quiz without cheating? Or is the quiz more of a self-assessment tool?

Title of educational scenario: ARE CONDITIONALS ASSOCIATED WITH BAD LUCK?

(During Phase B Synchronous) Ss discuss whether the given superstitions are also found in Cyprus and brainstorm/take a note of more Cypriot superstitions, their good or bad consequences and the possible reasons behind them. The discussion extends to why people believe in superstitions and the positive/ negative effects of believing in them.

Cultural elements constitute great opportunities for discussion. They help students re-examine their own identity, opening it up to other contexts, appreciate the value of their past and enrich their knowledge bank with information and experiences which contribute to their personal development. A web quest or project work could be a nice extension of this activity and it could add more interlocutors in this discussion, virtual or real.

The integration of digital media

Title of educational scenario: PRESENT PERFECT PRESENTATION

(During Phase A Asynchronous) The students will see some video clips about the present perfect and when to use it. They will focus on the 4 meanings of the present perfect showing video clips related to each of them

It takes much more than dividing your session in three parts and integrating digital media for a teacher to be able to say that they are making efficient use of the Flipped Classroom technique. Asking students to watch a video is not far away from a traditional lecture in a new cover. But then, what new does the Flipped Classroom technique have to offer? Learners watch the video at home at their own pace, they can pause and note down questions, repeat and make sure they understood something correctly.

Title of educational scenario: TO CONNECT OR NOT TO CONNECT

(During Phase B Synchronous) The teacher has created a word cloud with the students' views expressed in the forum and invites them to re-synthesize/present their views orally.

Moreover, integrating digital media during the synchronous phase of a flipped class encourages learners to collaborate, comment, share, and in the case of the word cloud activity above reshape their findings in a new product to develop another language skill, speaking but more importantly their critical thinking competency.

5. Conclusion

The Flipped Classroom technique can certainly constitute a part of an effective pedagogy for the teaching of English. Supported by the practices developed during the disruptions caused by the pandemic and fueled by the teachers' enthusiasm to embrace whatever seems to bring along better learning results, this model has great potential. Supported by well-informed decisions and planning which may be documented by educational scenarios and the theoretical scaffolding behind them, teachers add another promising means to their teaching quiver. Reflection and feedback exchange were a significant part of the process of working on the educational scenarios and suggesting ways of supporting teaching with digital technologies. The changing roles teachers and learners are invited to play, the abundance of the learning opportunities offered via activities and the critical participation of platforms, digital tools and applications can keep us optimistic about the school of tomorrow and connected to our conviction to keep developing and walking towards it.

6. References

Baker, W. J. (2000). The "Classroom Flip": Using web course management tools to become the guide by the side. In Selected papers from the 11th International Conference on College Teaching and Learning (S. 9–17). Jacksonville, FL: Florida Community College at Jacksonville.

Bergmann, J., & Sams, A. (2014). Flipping for mastery. Educational Leadership, 71(4), 24-29.

Bishop, J. L., & Verleger, M. A. (2013). *The flipped classroom: A survey of the research*. Atlanta, GA: Paper presented at the ASEE national conference proceedings.

Chen, C. C., & Jones, K. T. (2007). Blended Learning vs . Traditional Classroom Settings : Assessing Effectiveness and Student Perceptions in an MBA Accounting Course. *The Journal of Educators Online*, *4*(1), 1–15.

Cohen, S., & Brugar, K. (2013). I want that... flipping the classroom. Middle Ground, 16(4), 12-13.

Egan, S.M., Pope, J., Moloney, M., Hoyne, C. & Beatty, C. (2021). Missing Early Education and Care During the Pandemic: The Socio-Emotional Impact of the COVID-19 Crisis on Young Children. In *Early Childhood Education Journal* **49**, 925–934. https://doi.org/10.1007/s10643-021-01193-2

Errington, E. (2005). Creating Learning Scenarios (Palmerston North, New Zealand: Cool Books).

Farrell, T. (2008). Critical incidents in ELT initial teacher training. In *ELT Journal*, 62 (1), pp. 3-10.

Finch, A. (2010). Critical incidents and language learning: Sensitivity to initial conditions. In *System*, Volume 38(3), pp. 422-431.

Flanagan, J. C. (1954). The critical incident technique. *Psychological Bulletin, 51*(4), 327–358. https://doi.org/10.1037/h0061470

Friesen, N. (2012). *Defining Blended Learning*. *Learning Spaces*. Abgerufen von http://learningspaces.org/papers/Defining_Blended_Learning_NF.pdf

Fulton, K. (2012). Upside down and inside out : Flip your classroom to improve student learning. Learning & Leading with Technology, 39(8), 12–17.

Hamden, N., et al. (2013). A Review of Flipped Learning www.flippedlearning.org

Johnson, L. & Renner, J. (2012). Effect of the flipped classroom model on a secondary computer applications course: student and teacher perceptions, questions and student achievement. Doctoral Dissertation, University of Louisville.

Kalantzis, M., & Cope, B. (2010). Learning by Design. *E-Learning and Digital Media*, *7*(3), 198–199. https://doi.org/10.2304/elea.2010.7.3.198

Kamanetz, A. (2020, March 19). 'Panic-gogy': Teaching Online Classes During The Coronavirus Pandemic. *NPR.* Retrieved from https://www.npr.org/2020/03/19/817885991/panic-gogy-teaching-online-classes-during-the-coronavirus-pandemic

Karanicolas, S., and Snelling, C. (2010). Making the transition: achieving content connectivity and student engagement through flexible learning tools. In *Proceedings of the Distance Education Association of New Zealand (DEANZ) Conference,* Wellington.

Lage, M. J., Platt, G. J., & Treglia, M. (2000). Inverting the classroom: A gateway to creating an inclusive learning environment. *Journal of Economic Education*, *31*(1), 30–43.

Mazur, E. (1997). Peer instruction: A user's manual. Upper Saddle River, NJ: Prentice Hall.

Noonoo, S. (2012). Flipped Learning Founders Set the Record Straight. *Transforming Education Through Technology*. Retrived from https://thejournal.com/articles/2012/06/20/flipped-learning-founders-q-and-a.aspx

Schreiber, L. M., & Valle, B. E. (2013). Social Constructivist Teaching Strategies in the Small Group Classroom. Small Group Research, 44(4), 395–411.

Soini, H. (2012). Critical Learning Incidents. In: Seel, N.M. (eds) Encyclopedia of the Sciences of Learning. Springer, Boston, MA. https://doi.org/10.1007/978-1-4419-1428-6_543

Sun, L., Tang, Y., & Zuo, W. (2020). Coronavirus pushes education online. *Nature Materials, 19*(6), 687–687. https://doi.org/10.1038/s41563-020-0678-8.

Thiel, T. (1999). Reflections on critical incidents. In *Prospect*, 14 (1) (1999), pp. 44-52.

Tripp, D. (1993). Critical Incidents in Teaching: Developing Professional Judgment. Routledge, New York, NY.

Tomlinson, C. A. (2014). *Differentiated classroom: Responding to the needs of all learners*. Alexandria, VA: ASCD.

Tucker, C. R. (2020). *Balance With Blended Learning: Partner With Your Students to Reimagine Learning and Reclaim Your Life*. Thousand Oaks, CA: Corwin.

United Nations. (2020, August). Policy Brief: Education during COVID-19 and beyond. *United Nations.* Retrieved from https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2020/08/sg_policy_brief_covid-19_and_education_august_2020.pdf

Valiathan, P. (2002). Blended Learning Models. Abgerufen 9. Juli 2017, von http://purnima-valiathan.com/wp-content/uploads/2015/09/Blended-Learning-Models-2002-ASTD.pdf

Zhao, Y., Watterston, J. (2021). The changes we need: Education post COVID-19. In *Journal of Educational Change* **22**, 3–12. https://doi.org/10.1007/s10833-021-09417-3

Change of roles in the flipped classroom model

Vassiliki Bletsogianni, vbletsogianni@gmail.com

French Language Teacher, PhD candidate in French Language and Literature Department of Aristotle University of Thessaloniki

Abstract

Young people are raised from birth within the new digital era. We all live in and evolve new competencies in an attempt to succeed in our personal, social, and professional lives. The role of both teachers and students has significantly transformed the whole teaching process itself, too. Thus, a conceptual redefinition of the above in the context of flipped classroom, also providing its characteristics and distinctive stages of implementation, is deemed necessary. The study aims to highlight the transformation of the teacher-student role in the traditional as well as digital learning environments, in the context of educational interventions implemented to facilitate the educational and learning process.

Keywords: blended learning, flipped classroom, learning theories, traditional and virtual learning environment

1. Introduction

The rapid development of Information Technology and the utilization of its diverse and differentiated applications create new data in numerous fields of human activity within modern society. Typical examples that depict the dominance of IT can be found in various areas of professional, social, and private life, not to mention culture, and education. From the collaborative economy to the impact of social media on shaping the political landscape and the digital press, digital technology has affected many areas of everyday life, too (Serres, 2015). Specifically, in the field of education, Information, and Communication Technologies (ICT) “give anyone the opportunity to reflect upon and shift, in space and time, the collaborative communication between teachers and students, hence paving the way for the development of new learning or training activities” (Karsenti, Depover et Komis, 2007). What proves to be a major challenge for the school of the 21st century is the development of digital technologies wishing to guide, educate and prepare students so as to become free citizens of the digital society and progress through life in an uncertain, complex and hyper-connected world. Critical prerequisite for that is the renewal of both teaching and learning methods and strategies. One way to do it is by exploiting the different possibilities of access to information and knowledge. Another is by treasuring the role of the school as a solid point of reference for the multifaceted development of a person as an individual, on one hand, and a future citizen, on the other (Becchetti-Bizot, 2017).

The pedagogical use of ICT in education has led to the gradual decontextualization of teaching from space-time limitations, and the creation of electronic learning environments which support collaborative learning and the construction of knowledge by the learners themselves, and not its sterile reproduction by the teacher (Sofos, Kostas & Paraschou, 2015). In the digitally interconnected world, teachers and students are increasingly having free access to the global wealth of information, ideas and innovations, which allows them to participate more actively in the approach, production and dissemination of knowledge (Papadimitriou &

Sofos, 2022). The organization of hybrid work environments in the form of blended learning constitutes “the best possible osmosis between conventional ways of learning and distance forms of education with the aim of substantial interaction” (Miminou, Spanaka, 2013). By doing so, the educational interest has shifted its focus in an attempt to combine the positive elements of both conventional teaching and the use of new digital media, with an aim to maximize the learning outcomes (Garrisson & Vaughan, 2008). The flipped classroom is one of the most widespread models of blended learning, which includes various combinations of technological, pedagogical, theoretical, and methodological approaches. The utilization of this variety of techniques, media and theories renders flipped teaching an invaluable teaching option aiming to meet the different learning requirements. In light of the aforementioned capabilities, the ways we learn keep changing and new roles continue to emerge for both teachers and students.

2. Approach

The term "learning environment", which hosts the process of learning and is associated with the concept of the educational and learning environment, where the pedagogical action takes place in the form of various educational interventions (Giesecke, 2007) is usually associated with the school classroom or the university, the training room, the auditorium or the laboratory and refers to a traditional field of learning, which serves the didactic encounter between teacher and student, in which in many cases, face-to-face teaching still dominates (Sofos et al., 2015). However, today, traditional lectures in the classroom do not yield the necessary successful results as this method of speaking on the part of the teacher favors the transmission of ephemeral information (Hung, 2015, Mehring, 2016, Webb and Doman, 2019) and does not support essentially the student when working on their homework (Mehring, 2016). In recent years, the goals, needs and performance of students have changed, as they have immediate and easy access to the required information thanks to advanced technologies, the development of always available online cognitive content and the development of cognitive science, factors that are challenging to conventional teaching (Milman, 2012). Also, face-to-face teaching limits the learner to a passive attitude, in the role of listener, observer and reader, where, usually, the only source of knowledge is the school textbook and the study is done in a predetermined context due to the development of very specific strategies, techniques and teaching and learning processes.

The dynamic emergence of the flipped classroom, as a model of hybrid blended learning, shapes a new educational environment, where digital media and technologies activate—along with the conventional learning environment—a virtual learning field that requires pedagogical strategies appropriate to these new digital learning environments. According to Lebrun (2016), the flipped classroom is defined as a pedagogical approach in which the first exposure to the learning object takes place autonomously and remotely at a time that precedes the live encounter with the teacher. The preparatory stage can be performed with the support of various sources (books and other printed materials, websites, videos, software) as well as through the preparation of assignments (answering quizzes, carrying out research papers). Consolidation and deepening of knowledge is done with the aid of appropriate activities and interaction during the live meeting of teacher and students (discussion with the teacher and among groups, group cooperative activities, debating, joint problem solving, laboratory activities, peer teaching). It is noteworthy that flipped classroom design should not be limited to a mere replacement of in-class learning with watching videos at home and using in-class time just to do schoolwork (Lage et al., 2000).

Quite the opposite, in fact; the flipped classroom is defined as an open method that facilitates interaction between students and teachers, as well as differentiated learning (Bergmann et al., 2012; Keefe, 2007; Lage et al., 2000; Tomlinson, 2003) through a reversal of conventional learning not only inside but also outside the classroom, with the support of digital technologies alongside (Hugues, 2012). Consequently, there are four distinctive factors that define the flipped classroom model: a) the learning space (inside or outside the classroom) b) the medium of transmission (either the teacher or the technology) c) the learning type (frontal instruction or active learning), and d) the working style (individual or group) (Salta, 2017). In addition, what is noted is the transition from the frontal model of traditional teaching to a model that focuses on each student and their individual pedagogical needs (Bergmann et al., 2012, Honeycat & Garrett, 2014), maximizing, thus, the use of time in the classroom for the best possible assimilation of knowledge (Dumont and Berthiaume, 2016), the realization of teaching and learning in a digital environment (Lebrun, 2013), the enhancement of interaction (Bennett et al., 2011) and the involvement of students in the whole learning process (Williams, 2018). Technological innovations also contribute to the creation of a learning environment that fosters the development of an autonomous, self-initiated and self-regulated learning, as well as that of communicative and collaborative learning (Peters, 2003).

3. Results

Considering the above findings, the role of both the teacher and the student cannot remain the same. Teaching and learning are shifting from teacher-centered pedagogies and practices to student-centered approaches, where students are more actively involved in the learning process (Keamy, 2007). At the same time, the form of teaching changes, as—with the inverted/flipped approach—the transmission of information is often based on the use of digital educational content, which requires that teachers take on new roles. The teaching behavior is determined by shifting the focus point from presentation to the provision of advice and support, so that students can learn autonomously through exploration and discovery (Sofos et al., 2017). The first step towards the acquisition of knowledge in the flipped classroom is pre-classroom learning, which is transferred to an asynchronous environment. The presentation of the new knowledge to be acquired is done before the lesson, usually through audio-visual material, to which the students have access at home, but also through gathering information on the Internet, assigning tasks, recorded or video lectures (Hsieh, 2017), ready-made videos from websites, or educational sharing networks with digital content and free-use licenses, original, pre-recorded material in a variety of multimedia formats (Mazur, 2009; Demski, 2013), as well as documents or interviews (Vaughan, 2014). Students can refer to the learning material as often as needed, focus on any points they wish, in their own space and at their own pace. Thus, the students' interaction and familiarity with the educational material is upgraded in a way that does not usually occur when lectures are delivered in the traditional classroom. As a result, their self-confidence and degree of involvement in the learning process increases (Gariou et al., 2021).

At this point, it is worth mentioning that, according to Lebrun (2014), there are different categories of flipped classrooms, which are differentiated according to the roles of students and teachers and their relation with the acquisition of knowledge. In the most enriched types of flipped classroom, students—individually or in groups—engage in research, or search for information on a specific topic assigned to them, thus actively participating in the preparatory stage before coming to class. Students build the knowledge and locate the information needed in a context defined by the teacher. In class, they present the result of their research and share their knowledge. At this stage, the learning process is student-oriented, emphasizing the role shift between the teacher and the student. In this type of flipped classroom, it is not the teacher who presents the learning content in a multimodal form, but the students themselves who control the virtual multimedia learning environments in order to scaffold the new knowledge, develop new skills, become co-creators of the learning content, and complete their learning tasks in a meaningful way. Moreover, the teacher-to-student as well as the student-to-student collaboration can begin before entering the classroom using the communication tools of the teacher's choice learning/content management system. This system also serves as a repository of learning materials, including application activities that accompany the presentation of the learning object. Activities outside the classroom precede the live lesson and aim at the cognitive and psychological preparation of the students (Van Alten et al., 2020). Hence, the teacher posts short questionnaires in the form of quizzes, short tasks or topics for discussion, which the student answers before the lesson in class (Enfield, 2013). The teacher can also classify and grade the educational activities carried out at home in order to detect the individual needs of his/her students, identify any misunderstandings or difficulties in understanding new concepts and even design personalized learning paths (Katsa, 2014), which enables him to be better prepared targeted before entering the classroom (Vaughan, 2014). Within the classroom, the learning process is devoted to the application of active and participatory teaching techniques, since the delivery of new information has already been done, saving time for something more meaningful.

In the flipped classroom, the teacher is no longer the Sage on the Stage, but a Guide on the Side (Lebrun & Lecoq, 2015) who focuses on the importance of using classroom time to build knowledge through a variety of activities that promote active learning, rather than just impart information. Respectively, students must be ready and able to recognize the learning objectives set for them and then organize learning on their own, developing the ability to search, find and evaluate information through planned learning processes. Finally, after the completion of the asynchronous and synchronous phase of the learning process, the teacher is expected to design meta-learning environments/activities that aim to evaluate the acquired knowledge, integrate the new information into a new context of correlated cognitive contents, and create cognitive networks by the students themselves. Ideally, students transfer knowledge and skills from one learning context to another by applying what they have learned in situations that are as authentic as possible.

4. Conclusion

The transformation of the role of teachers and students is determined by the technological data of the time and the learning theories that underpin the implementation of the flipped classroom model, indicating the decisive role of constructive (cognitive) and sociocultural approaches, exploratory and discovery learning (Gariou, Makrodimos & Papadakis, 2021). Such methods place the student in the role of producer and co-creator of knowledge, offering an overall learning experience that is more constructive than the typical approach of acquiring ready-made knowledge. The main goal is to support the learner in the application of knowledge in order to solve problems that are more common in everyday life and professional environments, attributing value and meaning to the proposed activities (Poumay, 2014). The emphasis placed on a more active and participatory way of learning emphasizes the student’s value and sense of competence, which enhances learner motivation (Viau, 2009) and learner autonomy (Georges, 2010). Accordingly, the teacher takes on a more advisory, supportive, and encouraging role towards the learner, a renewed teaching role with his parallel activity in the production of a structured teaching material. Consequently, the role of the teacher is not limited to the mere delivery of the lesson, but now acts as a mediator and mentor who will inspire students to create a strong learning community; a community where students participate experientially in the construction of knowledge, foster collaboration and creative activation, and ensure a context of co-evolution in the learning of its members.

5. References

Becchetti-Bizot, C. (2017). Repenser la forme scolaire à l’heure du numérique : vers denouvelles manières d’apprendre et d’enseigner [Reconsider school in the digital age:

towards new ways of learning and teaching] Report No 2017-056 of the General Inspectorate of National Education. Retrieved November 17th, 2022 from: http://www.education.gouv.fr/cid122842/repenser-la- forme-scolaire-a-l-heure-du-numerique-vers-de-nouvelles-manieres-d-apprendre-et-d- enseigner.html.

Bennet B. E., Spencer D., Bergmann J., Cockrum T., Musallam R., Sams A., Fisch K., Overmyer J., 2011, The Flipped Class Manifest, The Daily Riff, Retrieved November 17th, 2022 from: http://www.thedailyriff.com/articles/the-flipped-class-manifest-823.php

Bergmann, J., & Sams, A. (2012). Flip your classroom: Reach every student in every class every day. Eugene, OR & Washington, DC: International Society for Technology in Education.

Demski, J. (2013). 6 Expert tips for flipping the classroom. Campus Technology. Retrieved October 10th, 2022 from: http://campustechnology.com/articles/2013/01/23/6-expert-tips-for-flipping-the-classroom.aspx

Dumont, A. & Berthiaume, D., (2016). La pédagogie inversée: Enseigner autrement dans le supérieur per la classe inversée [Flipped pedagogy: Teaching differently in higher education through the flipped classroom] Paris: De Boeck Supérieur.

Enfield, J. (2013). Looking at the impact of the flipped classroom model of instruction on undergraduate multimedia students at CSUN. Techtrends, 57(6), 14-27.

Garrison, D. & Vaughan, N. (2008). Blended learning in higher education. San Francisco, CA, Jossey-Bass

Georges, F. (2010). Mieux comprendre le savoir-agir autonome. Développement et analyse d'usages d'un environnement d'apprentissage destiné aux élèves de 10 à 15 ans [To better understand autonomous know-how. Development and analysis of uses of a learning environment for students aged 10 to 15] (Doctoral thesis, Liège University). Retrieved October 25th, 2022 from http://orbi.ulg.ac.be/handle/2268/118212

Honeycut, B., Garrett, J. (2014) Expanding the Definition of a Flipped Learning Environment, Retrieved November 27th, 2022 from: http://ecommons.med.harvard.edu/ec_res/nt/35B9D411-8F7C-48D4-A321-B996C46FD908/expanding_the_definition_of_the_Flipped_classroom.pdf

Hsieh, B. (2017). Step by Step, Slowly I Flip. In L. S. Green, J. R. Banas, & R. A. Perkins (Eds.), The Flipped College Classroom: Conceptualized and Re-Conceptualized (pp. 11-36). Switzerland: Springer International Publishing. Retrieved November 18th, 2022 from https://journals.openedition.org/ripes/778?lang=en&utm_source=feedly&utm_reader=feedly&utm_medium=rss&utm_campaign=six-leviers-pour-ameliorer-lapprentissage-des-etudiants-du-superieur

Hughes, J. N. (2012). Teacher-student relationships and school adjustment: Progress and remaining challenges. Attachment & Human Development, 14(3), 319-327.

Hung, H.T. (2015). Flipping the classroom for English language learners to foster active learning. Comput. Assist. Lang.Learn. 28, 81-96. doi: 10.1080/09588221.2014.967701

Keamy, K., Nicholas, H., Mahar, S., & Herrick, C. (2007). Personalizing education: From research to policy and practice. Melbourne: Office for Education Policy and Innovation, Department of Education and Early Childhood Development.

Keefe, E. B. (2007). Organizing literacy instruction. In S. R. Copeland & E. B. Keefe (Eds.), Effective literacy instruction for students with moderate or severe disabilities. Paul H. Brookes.

Lage, M. J., Platt, G. J., & Treglia, M. (2000). Inverting the Classroom: A Gateway to Creating an Inclusive Learning Environment. The Journal of Economic Education, 31(1), pp. 30-43. doi:10.1080/00220480009596759

Lebrun, M. (2013). Quand les flipped classroom font tilt [When flipped classrooms tilt] Retrieved November 15th, 2022 from: από: https://www.legrainasbl.org/index.php?option=com_content&view=article&id=428:quand-les-qflipped-classroomsq-font-tiltn&catid=54:analyses&Itemid=115

Lebrun, M. & Lecoq, J. (2015). Classes inversées : Enseigner et apprendre à l'endroit [Flipped classrooms: Teaching and learning] Réseau Canopé, Editions Maîtriser

Lebrun, M. (2016). Essai de modélisation et de systémisation du concept de Classes inversées [Model and systemize the concept of Flipped Classrooms] Marcel Blog. Retrieved November 12th, 2022 from bit.ly/ML-Classes-inversées

Mazur, E. (2009). Farewell, Lecture? Science, 323, 50-51.

Merhing, J. (2016). Present research on the flipped classroom and potential tools for the EFL classroom. Comput. Sch.33, 1-10. doi: 10.1080/07380569.2016.1139912

Milman, N. (2012). The flipped classroom strategy: what is it and how can it be used? Distance Learning. 9, 85-87.

Peters, O. (2003). Distance Education in Transition. New Trends and Challenges. Studien une Berichte der Arbeitsstelle Fernstudieforschung der Carl von Ozzietzky Universität Oldenburg. Band 5.

Poumay, M. (2014). Six leviers pour améliorer l'apprentissage des étudiants du supérieur [Six levers to improve student learning in higher education] International Journal of Higher Education Pedagogy. Retrieved November 15th, 2022 from http://ripes.revues.org/778

Serres, M. (2015). « On n'a jamais eu autant besoin des enseignants ! » [« We have never needed teachers so much!] (Interview with Michel Serres on April 3, 2015). Vousnousils: the e-mag of education. Retrieved November 15th, 2022 from www.vousnousils.fr/2015/04/03/michel-serres-on-na-jamais-eu-autant-besoin-des-enseignants- 566262

Tomlinson, B. (2003). Developing Principled Frameworks for Materials Development. In B. Tomlinson (Ed.), Developing Materials for Language Teaching (pp. 107-129). London UK, Continuum. (Quoted in Rico Troncoso, C. (2011). Principled Language Materials for the Development of Intercultural Communicative Competence. PhD Research Thesis, Leeds, UK: Leeds Met University.)

Van Alten, D., Phielix, C., Janssen, J.,& Kester, L. (2020). Effects of self-regulated learning prompts in a flipped History classroom. Computers in Human Behavior, 108,106318.

Viau, R. (2009). La motivation en contexte scolaire [La motivation en contexte scolaire] (2nd ed.). Bruxelles : De Boeck.

Webb, M. and Doman, E. (2019). Impacts of flipped classroom on learner attitudes towards technology-enhanced language learning. Comput. Assist. Lang. Learn. 33, 240-274 doi: 10.1080/09588221.2018.1557692

Williams, Johnnie; Ayadi, Olusegun Felix; Perkins, Carlton; and Hyman, Ladelle M. (2018) The Flipped Class: Experiential Learning Manifested, Southwestern Business Administration Journal: Vol. 17: Iss. 1, Article 1. Accessed at: 26/10/2022 from https://digitalscholarship.tsu.edu/sbaj/vol17/iss1/1

Gariou, A., Makrodimos, N., Papadakis S., (2021). Flipped classroom: a blended learning model for all levels of education Patras, Gotsis Publications.

Katsa, M. (2014). Action research to study the implementation of the "flipped" teaching model in the Algebra course of the B΄ Lyceum: its contribution to the more efficient use of teaching time and the learning results it brings]. (Bachelor's thesis). University of Piraeus, Piraeus.

Miminou, A. & Spanaka, A., (2013). School Distance Education: Record and Discussion of a Literature Review. International Conference on Open & Distance Education, Vol. 7, No. 2A (2013) doi: 10.12681/icodl.580

Salta, X., (2017). L’expérience de la classe inversée à l’enseignement du FLE au collège grec : vers l’acquisition des compétences transversales [L’expérience de la classe inversée à l’enseignement du FLE au collège grec: vers l’acquisition des compétences transversales]. Master thesis, Patras, EAP, June 2017.

Sofos, A., Kostas, A., Paraschou, B. (2015). Online distance education, Athens: Association of Greek Academic Libraries. Retrieved October 21st 2022 from https://hdl.handle.net/11419/182

Exploiting Digital Tools in Collaborative Learning Environments

Despina Andreadou , despina_andreadou@yahoo.gr

English Teacher

Abstract

It is an undeniable fact that only a limited number of today's teachers have experienced collaborative work in their own undergraduate settings. In the past, much of the graduate school training reinforced the teacher-centered, lecture-driven model of university teaching. In recent years, a significant number of studies have shown a growing interest in utilizing flipped learning as an innovative teaching method in education. At the same time, increasing demand for quick proliferation of knowledge has caused digital technology and the internet to take place in the learning process. In view of all these, this study aims to attract the attention of educators about the potential of incorporating digital tools in a flipped learning environment. It also attempts to form a point of view on how to use it in their courses.

Keywords: collaborative learning, flipped classroom approach, digital tools

1. Introduction

1. 1 Collaborative Learning

"Collaborative learning" is an umbrella term for a variety of educational approaches which involve joint intellectual effort by students, or students and teachers together (Goodsell, 1992). Typically, students work in groups of two or more to search for understanding, solve problems, complete tasks or learn new concepts. Therefore, collaborative learning is a shift away from the typical teacher-oriented classroom. Learning is an active process wherein constructing meaning and integrating new material with already acquired knowledge is crucial.

Another principle underlying the concept of collaborative learning is that learning fundamentally depends on rich contexts (Goodsell, 1992). Furthermore, it is essentially social in nature: "Collaborative learning has as its main feature a structure that allows for student talk: students are supposed to talk with each other .... and it is in this talking that much of the learning occurs." (Golub, 1988).

Collaborative learning activities may vary, but the majority of them engage learners to process and synthesize information and concepts, rather than simply rely on the teacher's presentation of the course material.

1. 2 Flipped Learning

In a traditional classroom, students listen, watch and take notes as the instructor covers new material. After class, students often work on assignments without guidance or feedback. In a flipped classroom, however, students have access to new material, readings, and resources before class. This frees up in-class time to address questions, collaborate with peers, and work on assignments. Students receive guidance and feedback at a time when it can help the most. These activities promote participation and create a deeper understanding of the content and how to use it. In this way, not only can students avoid passively accepting knowledge from instructors, but they can also improve their critical thinking along with high- level problem – solving skills (Francl 2014).

Collaborative in nature, flipping the classroom is a three-stage process:

Pre-Class

Rather than devoting precious classroom time to inform, communicate and generate awareness of the new material, teachers intentionally shift instruction to a learner-centered model. Students, prior to class, familiarize themselves with new content at their own pace, individually or collaboratively with peers. They may read physical or digital texts, watch an online lecture, review online course material, partake in an online discussion, conduct research. They can refer to the material as many times as they desire, and prepare for class by formulating and answering critical thinking or problem-solving questions. The instructor, then, reviews the results of the students' work and prepares in-class activities.

In-Class

Flipped classrooms also redefine in-class activities. Students, by using their personally prepared questions, are actively involved in knowledge acquisition and construction; they are encouraged to articulate their prior knowledge and demonstrate new understandings of the content. The instructor uses feedback to guide the education process and provides short demonstrations to clarify material if it is required. Class activities may include: presentations, laboratory experiments, debate, current event discussions, peer assessment and review, project-based learning (Sparks, 2011).

Post-Class

More often than not, the learning process does not end with the in-class activity. Instead, students continue applying newly constructed knowledge to more complex tasks. They work individually or in small groups to solve problems or collaborate on projects and receive immediate feedback so that they remain aware of their progress and motivated to improve. Assessment and evaluation of student work are based on these efforts.

1.3 Bloom's Taxonomy

The educational objectives of flipped learning set by educators for their students can be addressed based on the Taxonomy of Educational Objectives initially proposed by Bloom (1956) and updated by Anderson and Krathwohl.

Bloom's taxonomy sets out a series of learning objectives providing a useful structure for instructional design. According to Bloom's taxonomy the learning process is divided into three psychological domains – cognitive (processing information), affective (attitudes and feelings) and psychomotor (physical skills). It was updated in 1990 by Anderson and Krathal to express a current emphasis on active learning and can be used to determine the levels of understanding that students are expected to demonstrate.

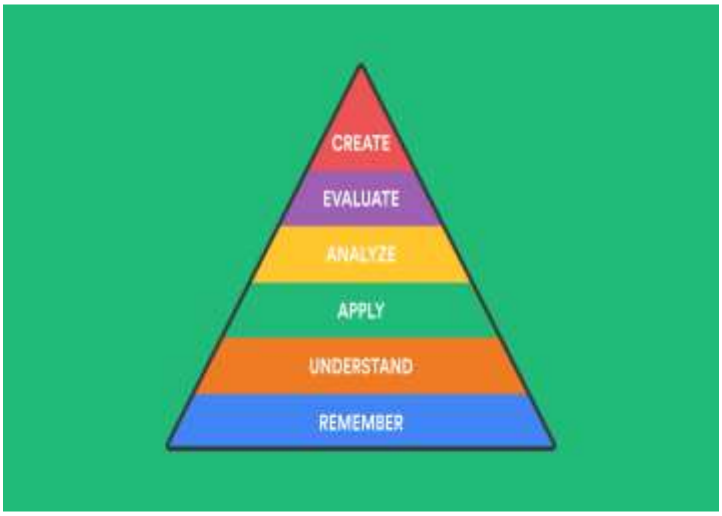


Figure 1: Bloom's Taxonomy of Intellectual Behaviors

The six levels of Bloom's taxonomy as illustrated in Fig. 1:

Remembering: Students define, list, memorize, recall, reproduce new information

Understanding: Describing, explaining, classifying, paraphrasing ideas or concepts.

Applying: Can students use the information in a new way? Can they implement what was acquired in the 'Remembering' and 'Understanding' phases?

Analyzing: Students should be able to break information into constituent parts, establishing how they relate to each other. Also, they could simplify complex information or summarize it.

Evaluating: Can students justify a viewpoint or decision? To evaluate information, students might argue, defend, judge or support.

Creating: This level draws on all the other levels with students putting elements together to formulate a new, coherent and functional whole.

In flipped learning, what students do before and after the class is associated with remembering and understanding, namely the lower levels of cognitive learning. Instruction through videos is used to present the basic contents of the target subjects. In class, discussion, collaborative learning activities, individual guidance, and other strategies are employed to promote students' self-reflection ability which helps them attain higher levels of cognitive learning; these include applying, analyzing and evaluating (Hwang et al. 2014).

2. Approach

The purpose of this paper is to review relevant literature and research in order to present the potential value of digital tools in a flipped classroom learning environment, mainly collaborative in nature and to examine how these tools can be exploited in order to facilitate the learning process, foster students' self-learning ability and enhance their overall performance.

The two main research questions that need to be addressed are:

(1) which are the main digital technologies that can be employed in order for teachers to implement the flipped learning approach effectively?

(2) which is the optimal way to integrate digital technologies to make learning through flipping a truly meaningful experience for both teachers and learners?

Specific digital tools are described for flipping using a three-stage framework for instructional design that involves learning in both asynchronous and synchronous environments.

Results

Integrating Digital Tools and Resources with Flipped Model Learning

While a number of scholars have argued that technology is not a necessary element for flipping the classroom (Hwang et al. 2015), it can, however, add value in many ways to the "blend" of in-class and out of class experiences, thus providing an effective and engaging learning environment.

An abundance of research literature supports how employment of digital tools promotes active learning which in turn leads to increased students' retention, motivation, and persistence with the learning material. That being the case, it becomes evident that technology should not be used merely for absorbing inert knowledge, but for engaging students in more active participation. To be successful, teachers need each time to define the learning objectives and students' needs and abilities, appropriately select the methods of instruction and assessment and evaluation strategies that will best facilitate the intended learning and then choose the tools that will best deliver the learning content (Clark 2001).

There are numerous digital tools and resources that can be used to accomplish the goals of the flipped learning approach.

3.1.1 Learning Management Systems (LMS)

A Learning Management System (LMS) is the infrastructure that allows teachers to deliver and manage instructional content, assess learning goals, track the progress rate of learners, identify students' needs and collect data for supervising the learning process as a whole (Szabo & Flesher, 2002). By logging on to the platform learners can watch relevant videos or other instructional material and discuss course content with the instructor and with their classmates so that initial absorption and internalization of knowledge is achieved. In this way, the pre-class component of the flipped classroom is realized and the platform becomes a repository for any kind of useful learning material.

Instructors can create and upload their own videos or make use of pre-recorded lectures created by third parties. They can select from numerous online resources, such as ***Khan Academy, TedEdu*** or ***Crash Course.*** These offer thousands of hours of video lessons on a variety of topics like science, history, literature, social science, politics or culture, allowing students to work at their own pace. In fact, an early application of the concept of flipped classroom was the chemistry course taught by Bergmann, Sams and Khan's teaching video which unintentionally benefited students whose academic performance was lagging behind; thus, this online video teaching system became the famous ''Khan Academy.''

Some of the most widely used Learning Management Systems that can support the flipped classroom are ***EdModo, Moodle*** and ***Sakai***. They all feature unlimited storage options and include tools for emails, chat rooms and polling tools while their interface is particularly user-friendly. Also, Cloud-based LMSs have recently emerged. These do not require installation of an LMS platform and are used to deliver education online to any student, at any time and anywhere around the world, so long as there is connection to the Internet and a tool (i.e., computer, tablet or a smartphone).

3.1.2 Web-conferencing Applications

A flipped classroom is not just about watching the lectures before going to class. It also entails students engaging in thoughtful conversations and collaborative thinking or communicating their ideas. Flipped learning involves peer-to-peer teaching, review, or sharing knowledge (either in class or online), students working with a partner to collaborate on an assignment (either in class or online), students discussing ideas, solving problems, or answering questions with a partner. The instructor poses conceptual questions, to which students reflect, respond, discuss, and attempt to reach consensus on the answers in small groups.

Such tools for learning, communication and engagement which in turn can lead to a more productive learning experience include: Google Meet (previously Google Hangouts), Wikispaces, Zoom, Skype, WebEx.

These applications allow instructors to record class time, take a poll, form a virtual club, use the polling feature to gather student feedback, and invite guest speakers. Also, they enable students to ask questions live or in chat and they provide the space for virtual breakout rooms, where students can work in pairs or small groups for peer editing and feedback.

3.1.3 Online assessment tools

Prior to class time the instructor needs to assess student knowledge in order to identify diverse learner needs as well as areas that require clarification or emphasis. In this way, he / she can make informed decisions about what in-class adjustments to make, what content to deliver and how to deliver it in a way that makes the most of class time and leads to an enhanced learning experience. Moreover, measuring the efficacy of the learning process is a very important aspect of education. Instructors need to appraise the impact of their teaching method and so they may conduct regular assessments of student knowledge, skills, and attitudes toward a particular topic in the post-class phase.

There are a number of tools available that can be used to collect learner's feedback.

Socrative

Socrative provides an online platform which students and teachers can access through any web browser, mobile phone, tablet or laptop. There is a variety of educational games and exercises to choose from and integrate into each student's electronic device.

Google Forms

This is yet another useful tool for the flipped classroom model which helps to get insights quickly and collect useful data from students. Google Forms features the following characteristics:

Self-grade with an answer key

Deliver feedback to students

Feedback can be given for both incorrect and correct answers and it can appear either as a simple message or as a hyperlink to a website or a YouTube video. Also, the instructor may download results to Microsoft Excel for further analysis.

Adapt and change based on student responses while they are completing the Form

Not only does it analyze responses in real time but it also adapts and changes the questions as students' progress through their work.

3.1.4 e-Portfolio

During the post-class phase of the flipped learning process learners need to reflect on their work, to critically assess that work, and continue to apply newly constructed knowledge to more complex tasks. ePortfolios provide an excellent way to document student progress and according to Basken (2008) they "are a way to generate learning as well as document learning". They should not, however, be confused with Learning Management Systems which are controlled and managed by the instructor. In the case of an ePortfolio, the student is in charge: it is the student who decides who can view the ePortfolio or how it is designed. Typically, a student has no further access to the LMS when courses end. In contrast, ePortfolios remain the student's property. Electronic portfolio features are available through online applications including ***Wix*** and ***Weebly***.

3.1.5 Hosting Sites

YouTube

YouTube enables teachers to create public videos as well as restrict them for viewing to only their students. YouTube allows you to add annotations and link them to other pertinent videos.

Screencast.com

A free account on this hosting site offers ample storage space thus enabling its users to upload a considerable number of video-clips, podcasts and images and PDF documents. Another feature of Screencast is that content is not public. Only people who are invited are able to view the content.

Dropbox

Dropbox is an effective tool for the flipped classroom model since it enables its users to save and access their files from any device and share them with anyone.

Discussion

Technology has turned into an effective way of presenting the learning content. Incorporating digital tools in a collaborative classroom can prove to be a very rewarding opportunity when used appropriately. At the same time, educators are presented with numerous challenges and dilemmas. Incorporating digital technology in the flipped classroom environment requires a substantial amount of effort and cooperation from instructors and students. It is essential that educators are well aware of students' needs and expectations.

Therefore, to successfully apply and adopt the flipped classroom model within the context of a digital educational space, teachers are advised to:

• take into consideration students' individual expectations and needs when constructing the flipped classroom;

• explain to students how to study independently and use digital tools and resources to their advantage.

References

Abourbih, J. and Witham, R. (2007). "Using web based conferencing and presentation software to improve teaching effectiveness and the learning environment," in Proceedings of World Conference on ELearning in Corporate, Government, Healthcare, and Higher Education 2007, T. Bastiaens and S. Carliner, Eds. Quebec City, Canada, 1364-1365.

Anderson, L. W., & Krathwohl, D. R. (2001). A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives. New York: Longman.

Aronson, N. & Arfstrom, K. M. (2013). *Flipped learning in higher education*. Retrieved from http://www.flippedlearning.org/cms/lib07/VA01923112/Centricity/Domain/41/HigherEdWhitePaper%20FINAL.pdf

Basken, P. (2008, April). Electronic portfolios may answer calls for more accountability. *The Chronicle of Higher Education.*

Bergmann, J. & Sams, A. (2012). *Flip your classroom: Reach every student in every class every da*y. Washington, DC: ISTE; & Alexandria, VA: ASCD.

Berrett, D. (2012). How 'Flipping' the classroom can improve the traditional lecture. *Chronicle of Higher Education*. Retrieved from http://chronicle.com/article/How-Flipping-the-Classroom/130857/.

Chang, L. C., & Lee, G. C. (2010). A team-teaching model for practicing project-based learning in high school: Collaboration between computer and subject teachers. Computers & Education, 55(3), 961–969.

Hoffman, B., & Ritchie, D. (1997). Using multimedia to overcome the problems with problem based learning. Instructional Science, 25, 97–115

Hwang, G. J., Tsai, C. C., & Yang, Stephen J. H. (2008b). Criteria, strategies and research issues of context-aware ubiquitous learning. Educational Technology & Society, 11(2), 81–91.

Hwang, G. J., Lai, C. L., Wang, S. Y. (2015). Seamless flipped learning: a mobile technology-enhanced flipped classroom with effective learning strategies. *Journal of Computers in Education,* 2 (4), 449-473

Francl, T. J. (2014). *Is flipped learning appropriate?* (pp. 119–128). Claytin: Publication of National University.

Golub, J. (Ed). Focus on Collaborative Learning. Urbana, IL: National Council of Teachers of English, 1988.

Goodsell, A. S. (1992). Collaborative Learning. A Sourceful for Higher Education. National Center on Postsecondary Teaching, Learning, and Assessment, University Park, PA.

Kim, M. K., Kim, S. M., Khera, O., & Getman, J. (2014). The experience of three flipped classrooms in an urban university: An exploration of design principles. Internet and Higher Education, 22, 37–50.

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.

Nicolaidou, I. (2013). E-portfolios supporting primary students' writing performance and peer feedback. Computers & Education, 68, 404–415.

Moreno, J. (2012). Digital competition game to improve programming skills. Educational Technology & Society, 15(3), 288–297.

Ozdamli, F. & Asiksoy, G. (2016). Flipped classroom approach. World Journal on Eduactional Technology 8 (2) Available on: https://doi.org/10.18844/wjet.v8i2.640

Szabo, M., & Flesher, K. (2002). CMI theory and practice: Historical roots of learning management systems. Paper presented at the E-Learn 2002 World Conference on E-Learning in Corporate, Government, Healthcare, & Higher Education, Montreal, Canada.

Sparks, Sarah D. (2011). "Lectures Are Homework in Schools. Following Khan Academy Lead". *Education Week. Lawrenceville, GA.*

Presenting educational scenarios for Mathematics

Aikaterini, Glinou (1), aikaglinou@sch.gr

Georgios Kosyvas (2), gkosyvas@gmail.com

(1) *Coordinator of Mathematics educators*
(2) *Regional Director for Primary and Secondary Education of Education of Attica*

Abstract

This paper presents the teaching scenarios for Mathematics developed within the framework of the Erasmus+ KA2 European Programme of the Regional Directorate of Primary and Secondary Education of Attica, in collaboration with Universities and Institutions in Italy, Cyprus and Greece, with the title "Up-skilling of schools' teachers to effectively support Online Education", "CONNECT". The scenarios are developed using the blended learning model and the flipped classroom methodology. They aim both at the integration of Information and Communication Technologies into the educational process as well as at the adoption of the "blended learning" model and the "Flipped Classroom" methodology in everyday teaching practices of Mathematics.

Keywords: Teaching scenario, Lesson plan, Blended learning, Flipped classroom

1. Introduction

The term teaching scenario, (teaching situation, Brousseau, 1997) refers to the comprehensive, detailed, and structured description of a teaching process, which focuses on one or more subjects having specific educational goals, and is based on specific teaching and pedagogical principles.

The teaching scenario or educational scenario usually lasts for more than one teaching hour. One or more digital tools may be used in the teaching scenario, but the use of technology must be considered, not simply as an innovation, but as a necessity, which gives the learning process additional didactic and pedagogical value.

The teaching scenario is related to the lesson plan which describes a time-limited lesson (1 to 2 teaching hours), it is closely related to the curriculum and has been linked to a behavioral description of teaching. In the lesson plan, both the interaction and the roles of the participants are not presented most of the time, as opposed to what is happening in the teaching scenario.

On a daily basis, the terms teaching scenario and lesson plan tend to frequently coincide, especially when the teaching lasts for 1 to 2 teaching hours, "in the sense that today, a lesson plan must also include the interactive and collaborative dimension of teaching, etc.» as stated in the Training material for the training of teachers, Issue 1 (General Part). (Training of Teachers for the Utilization and Application of ICT in Teaching Practice, issue 1, Patras, February 2010, in Greek).

The teaching scenario describes the target group, the main aim as well as the objectives of the teaching process, the phases of the teaching, the proposed time of duration for each phase in the development of the scenario, the equipment that will be used in the teaching, the difficulties that may arise, the soft skills of the students intended to be developed, and, finally, the students' prerequisite prior knowledge that will allow for the application of the scenario.

Additionally, the teaching scenario describes the relationships between the participants and the roles that they will have, their perceptions, their misunderstandings, the difficulties of the students and the teaching obstacles that may arise (Dagdilelis & Papadopoulos, 2004). It also describes the forms of students' assessment and the teacher's evaluation of the teaching process.

The implementation of the teaching scenario, which also includes worksheets, is usually carried out through activities implemented by students. An activity is considered to be anything that the teacher can use in the classroom, such as discussions, analyses, proposals, solving problems, dealing with realistic problems, role playing and dramatization, synthetic work, etc. (Tzimas, 2009).

It is absolutely necessary to encourage students to actively participate in the learning process in investigating practices and in adopting collaborative and inclusive attitudes. The teaching scenarios consist of two sections; the section for the teacher (Identity of the scenario, Brief presentation of the scenario, Description of the course of teaching, Evaluation, References) and that one for students (worksheets and possibly the instructions for their answers).

When it comes to the "CONNECT" European Programme, the teaching scenario is considered to be the written description of a teaching practice, which takes place at a predefined place and time and under specific pedagogical conditions, at the end of which specific learning outcomes are expected, which have been already defined as goals.

The designed scenarios can be used in the following ways. Firstly, we can either use them as they are designed as material for teaching in certain units. They can also be modified according to the needs of the students, or even incorporated in some of the activities proposed, so that teachers will achieve their goals.

Pillars of the scenarios in the Erasmus+ "CONNECT" European Programme are the inclusion of Information and Communication Technologies (ICT) in the educational process, as well as the utilization of the "Blended Learning" model and the "Flipped Classroom" methodology.

The term "Blended Learning" refers to the teaching methodology that combines face- to-face learning with distance learning. In the aforementioned, students learn in their own space, at their own pace. The teacher has the opportunity to act as an active designer and orchestrator of his/her teaching in every phase of teaching in order to identify the students' needs and weaknesses as well as provide them with the appropriate support and instant feedback.

The term "Flipped Classroom" refers to the teaching methodology in which the learning content is transferred to the students remotely, usually through a video presentation meaning that the traditional teaching practices are reversed. Students can attend "the lesson" at their place, and then, during the face-to-face teaching, they can apply what they have already learnt, to formulate and solve problems, and strengthen the relationships among all of those involved in the learning process. Teachers can transfer knowledge to students through textbooks or online, and the resources that the teachers may use can be texts, audio files, websites, videos, etc.

An important advantage of the application of methodology of Flipped Classroom is that the students get new knowledge, working on the lower levels of Bloom's taxonomy (Remember-Understand), while in class the students collaborate with the teacher and interact with their classmates working at the highest levels of Bloom's taxonomy (Apply-Analyze-Evaluate-Create). During the third phase of teaching, in distance education, they usually work at the levels of Evaluate-Create, depending on the teacher's suggestions.

The scenarios in the "CONNECT" programme are developed in three phases. In the first phase, through distance teaching and learning, the students contact with the new knowledge. In the second phase, during face-to-face teaching, the students, using the knowledge they have acquired in the first phase, engage in activities that will help them understand and consolidate the new knowledge. The third phase is implemented by distance learning and may encompass teaching evaluation, students' self-evaluation, their assessment and feedback.

Several scenarios have been developed for Physics, Mathematics and Foreign Languages.

2. Approach

The teaching scenarios of Mathematics in the European programme Erasmus+ KA2 "CONNECT"

The Mathematics Curriculum is still considered to result in theoretical knowledge, taught by traditional teaching, even though many attempts have been made to prove otherwise. Students feel that they have to learn abstract definitions by heart and that they have to be able to prove theorems and work on difficult and complicated exercises that have nothing to do with everyday life. If the students' anxiety and phobia about Mathematics is added up to that, we end up with students who do not understand the lesson content and, as a result, they dislike it. However, when it comes to the mathematics' education, "our goal is to strengthen the logical-mathematical aspect of students' thinking and its expression as an integral part of our culture and civilization" as stated in the material for the training of teachers at the Training Support Centers for the teaching of Mathematics (Training of Teachers in the Use and Utilization of ICT in the Teaching Process, Patras, May 2008, in Greek). Therefore, there is a need to design and create mathematical environments characterized by dialogue, experimentation, discoveries, multiple representations of concepts and students' active participation in order to acquire knowledge.

The design of a teaching scenario for Mathematics is a real challenge for a teacher, since he/she must integrate the design of the lesson, the pedagogical and teaching principles on which it is based, but also document the use of technology in order to effectively serve the intended learning outcomes.

In the European Programme "CONNECT", a total number of nine teaching scenarios for Junior High School was designed for the subject of Mathematics. Three cooperating countries, i.e. Greece, Italy and Cyprus participated in the programme.

The following scenarios were designed in Greece:

1.Teaching the identity $(a+b)^2=a^2+2ab+b^2$

2. The Linear System of two equations with two unknowns and its Graphical solution

3. Linear inequalities in everyday life

The following scenarios were designed in Italy:

1.Surface area of a cylinder

2.Pythagorean theorem

3. Introduction to polynomial

The following scenarios were designed in Cyprus:

1.Teaching of First degree Inequality

2.Teaching Pythagorean Theorem

3.Teaching of Triangle-Sum Types of Triangle Angles

The nine scenarios were designed to be implemented with Blended Learning using the Flipped Classroom methodology in the framework of the "before", "during" and "after" method. The teacher, taking into account the pre-existing knowledge of his/her students and their interests, plans his/her teaching so that the students acquire knowledge, while at the same time develop soft skills such as cooperation in groups, creative and critical thinking, problem solving, inquiry, decision-making, communication skills and digital skills. Blended Learning is a new experience for students, because it combines the advantages of face-to-face and distance learning with the use of the Internet. The aim, goal as well as expectation is for the scenarios designed for Mathematics to function as teaching suggestions, but also as a starting point for teachers to design their own scenarios that will meet the needs of their own classes and reflect their own aspirations for the learning and teaching of Mathematics. They can also be used as issues for discussion and reflection with the ultimate goal of upgrading the teaching of Mathematics. The organization of the class is an important factor for the success of the implementation of the scenario.

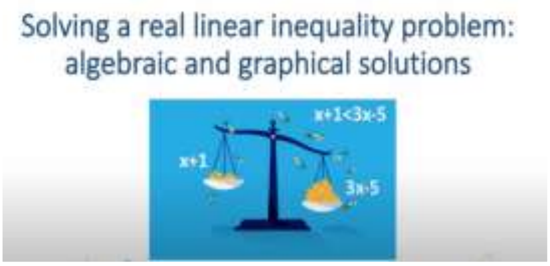


Figure 1. Linear Inequalities

Figure 2. Interactive video

In the Mathematics' scenarios, group work, individual work followed by group, work and whole class work, have been selected.

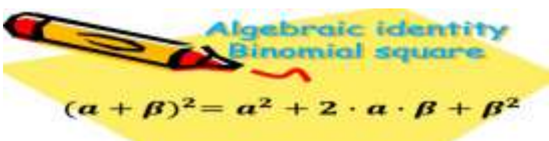


Figure 3. Algebraic Idemtities

In the teaching scenarios, during the first phase of teaching and through distance learning, the students use an electronic platform, which varies according to each country that has developed the scenario, (e-class, e-me, google classroom) and watch a video -presentation to introduce them to the new knowledge. Some videos are made by the creators of the scenario, for example https://youtu.be/41j3O7kRSwU and some can be found on YouTube, for example https://www.youtube.com/watch?v=jLCftTjDLO4

Some videos are interactive like https://content.e-me.edu.gr/wp-admin/admin-ajax.php?action=h5p_embed&id=1125085. This means that while the students watch the video, some questions appear on the screen which have to be answered and for which they get feedback.

In some scenarios, the students interact with each other and the teacher through the e-learning platform and complete worksheets, which they will then send to the teacher. In some scenarios, e-mail is used so that the students will communicate with the teacher. The teacher sends worksheets to the students via e-mail and they send their answers back in the same way.

Figure 4. Frayer graphic organizer

In the scenario "Teaching the identity $(\alpha+\beta)^2 = \alpha^2+2\cdot\alpha\cdot\beta+\beta^2$ " students raise their questions and interact in a forum, in the e-class platform, where they can help one another and start a dialogue about Mathematical issues that concern them. Italy used google classrooms for the interaction of students and teachers. In the scenario "Teaching the identity $(\alpha+\beta)^2=\alpha^2+2\cdot\alpha\cdot\beta+\beta^2$" as well as in the scenario about the linear system of two equations with two unknowns, the application of elements of differentiated teaching has been undertaken, such as the application of the Jigsaw method and the use of the Frayer graphic organizer. For more detail see:

https://docs.google.com/document/d/1hYFcaPAin9XxKgukN_KUzYf1Em2eoCxQ/edit?usp=sharing&ouid=110311086047101024055&rtpof=true&sd=true

The use of differentiated teaching was chosen because it is known from research that there are students who have low performance in Mathematics during their studies in High School. The aim of differentiated teaching is to motivate students to develop their cognitive and metacognitive skills and improve their performance (Gagatsis & Koutselini, 2000). It is generally accepted that student learning does not depend on what the teacher does in the classroom, but whether what he/she does in the classroom activates the students and helps them develop cognitive schemes (Koutselini, 2001). One should always bear in mind that in a Mathematics class, students differ from one another in the way and pace in which they learn, in terms of their readiness and in terms of their knowledge of the use of the Greek language. On the other hand, it is an undeniable fact that one must meet the needs of all students for inclusion and support. Therefore, the teacher has an obligation to create the learning conditions that can support the needs and highlight the particular experiences and inclinations of all students. The Jigsaw method favors collaboration between students with different experiences and abilities, in order to complete the task assigned to the group and achieve learning. The active participation and interaction of all members of the group is a prerequisite. The Frayer's graphic organizer enables learners to describe the linear system of two equations with two unknowns in 4 different ways. The first way is the formulation of the definition. The second one has to do with the reference of the characteristics of the linear system of two equations with two unknowns. In the third way, the students write down examples for the concept of the linear system and in the fourth way, they record non-examples in order to better understand the definition.

The use of manual tools is useful in specific scenarios. Students construct the cylinder, create posters demonstrating the solutions to problems, or create the geometric representation of the identity "square sum of two terms". The goal is to achieve visualization that can help reinforce mathematical thinking and the understanding of concepts.

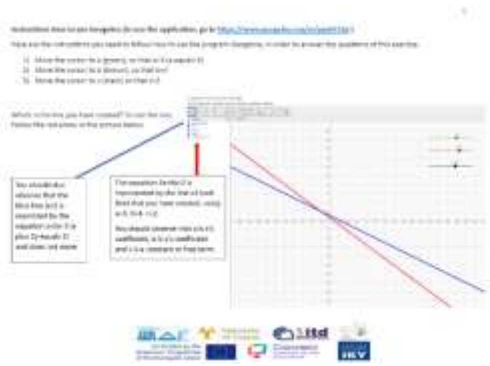


Figure 5. Instractions for Geogebra

During the development of the scenarios, the creators have integrated a number of frequent students' errors, such as $(\alpha+\beta)^2= \alpha^2+\beta^2$, or the interpretation of the symbols in first- order equation and first-order inequality, when it comes to the number of their solutions. Further discussion is attempted in order to clarify any misunderstandings.

Alternative routes for didactic utilization or extension of activities are included in the majority of the Mathematical scenarios that have been developed. Furthermore, instructions for preparing worksheets or using applications are included, where this is deemed necessary.

https://docs.google.com/document/d/1gM6S7E8oh3jTqafIEK3Dlozut_CAMZAU/edit?usp=sharing&ouid=110311086047101024055&rtpof=true&sd=true .

In some scenarios, creators use tools for the dynamic manipulation of concepts, aiming to upgrade the quality of mathematics teaching. This way, the student's or school's computer, tablet or laptop are used to explore mathematical concepts, to create representations and for teamwork and communication. In this context, the Geogebra programme is used, giving pedagogical value to the teaching and providing the student with the ability for dynamic manipulation of some concepts, in order to study and understand areas of mathematics.

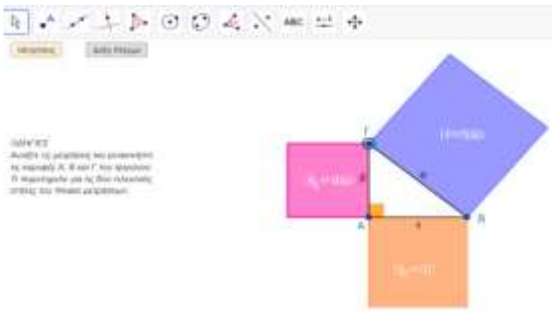


Figure 6. Geogebra for Pythagorean Theorem

According to Kynigos (Kynigos, 2011), the use of digital technology has additional pedagogical value as "it can provide multi-representational tools with which the student can acquire experiences on expressing concepts and on scientific argumentation, on managing information, on acting in diverse collectives, on practicing judgment and creative questioning". For example, the Geogebra application is cited at:

https://www.Geogebra.org/m/nrmxrqhn

Figure 7. Game in Genial.ly

The genial.ly application was used in some scenarios in Italy, mainly in the evaluation of trainees. For example, this application is used in the scenario for teaching the Pythagorean theorem by playing the Mystery Breakout online game. https://view.genial.ly/604feb77ce174c0d20267699/interactive-content-pythagorean-theorem

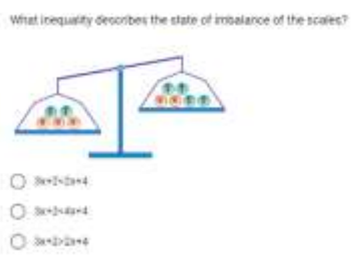
In the Mathematics scenarios, the assessment of a student's achievements, the cooperation during group work, as well as the student's self-assessment are definitely a desideratum. The answers to the questionnaires can provide teachers with feedback on the learning process, can act as topics for discussion and opportunities for active participation during the course. Clues for formative assessment can also arise by inspecting the quality of homework the students send to the teacher as well as by the students' participation in the discussions with their classmates.

Indicative examples of the evaluation sheets created are the following:

https://docs.google.com/forms/d/e/1FAIpQLSdhiI98K9stJ9lDkTblUkG1MyHPZVI7GXhQkUrTCA5XwIt05Q/viewform

https://docs.google.com/forms/d/e/1FAIpQLSdI2EkHRxqSzGMczbKU438C_O2SFYxNaQq-vuW92K-Frql2Iw/viewform

https://docs.google.com/forms/d/1lVHUekKp0hkBSfHbjUHu56hSpvsK9_i8xcPWhgn5Cfg/viewform?edit_requested=true



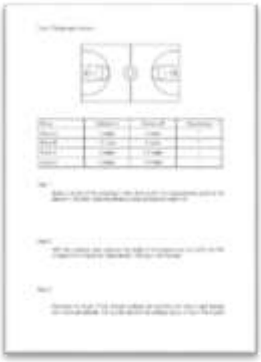
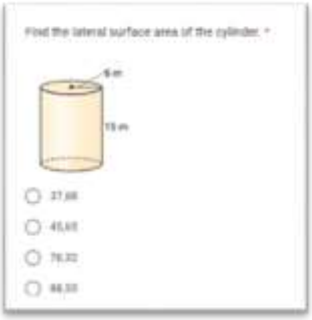



Figure 8. Evaluation sheets

3. Discussion

The Mathematics scenarios are expected to be implemented in the classroom between January and March 2023. The recordings of the teachers who will implement them are expected to provide a lot of information about the success of the scenarios in the teaching of Mathematics. They are also expected to establish the effectiveness of blended learning and flipped class on the students' performance and on their involvement in the learning process. Some questions that may arise and should be answered are the following:

Did the teaching of Mathematics through the proposed process affect the academic performance and engagement of the students? Did the students watch the videos at the pre-class stage? Were the students adequately prepared for face-to-face teaching? Were there any major misconceptions in the video material they studied? Did the teachers note any significant differences in students taking responsibility for their own learning compared to conventional teaching? What factors made the process more difficult? To what extent were the students satisfied by the teaching? Were the students able to work together in groups, what obstacles existed? Did the use of the flipped classroom help in saving teaching time and did it support the face-to-face teaching of those students who had educational needs? What is the cost-benefit of all the extra time spent by the teacher making videos or finding materials? Did the group work contribute to the socialization of the students? Were there any failures in the design of the scripts and where were these detected? Are the Mathematical scenarios that have been developed implementable within the existing conditions in schools?

4. Conclusion

Even though the traditional way of teaching remains the choice of many teachers of Mathematics, it does not seem to be enough to meet the growing demands in education in nowadays' society. The Internet plays an important role in our everyday lives and seems to be able to provide solutions for students' learning, something made particularly clear during the pandemic period. Many studies have documented the effectiveness of blended learning as a process that can combine the advantages of distance and face-to-face teaching and learning. It may also contribute to a rise in students' involvement in the learning process, an increase in their commitment, a strengthening of self-image while giving students the opportunity to learn in their own time and place, at their own pace. Moreover, the use of the flipped classroom methodology allows the sparing of teaching time, so that it may be possible to support students with special educational needs during face-to-face teaching. The European Programme "CONNECT" created the opportunity to design scenarios in Mathematics using blended learning and the Flipped Classroom. This is a significant opportunity for using these scenarios in classroom, either during the teaching of the relevant units of Mathematics, or modified by teachers according to their goals and the needs of their own students, or even to create a subject for Mathematical discussion, for the benefit of the teaching of Mathematics in High School.

5. References

Brousseau, G. Theory of Didactical Situations in Mathematics. Didactique des Mathematiques, 1970-1990. Mathematics Education Library. Volume 19. e-Book ISBN: 0-306-47211-2.

Gagatsis, Ath. & Koutselini, M. (2000). "Curriculum Development as Praxis and Differentiation in Practice: The case of Mathematics" in Koutselini, M. (2006) "Strategies for differentiating teaching in the school classroom". Pedagogical Review, 41, in Greek.

Dagdilelis, B. & Papadopoulos, I. (2004)." Teaching scenarios and ICT in Mathematics: a practical guide", in Greek.

Training of Teachers in the use and Utilization of ICT in the Teaching Process, Training material for the training of teachers in Training Support Centers, Issue 4: Branch PE03 1st edition (02-05-2008), Patras, May 2008, in Greek.

Training of Teachers for the Utilization and Application of ICT in Teaching Practice, Training material for the training of teachers in Training Support Centers, Issue 1: General part A' edition (06-02-2010), Patras, February 2010,in Greek.

Koutselini, I. M. (2001). Program Development: Theory, Research, Practice. Nicosia.

Koutselini, M. (2006). Strategies to differentiate teaching in the school classroom. Pedagogical Review, 41,in Greek.

Kynigos, X. (2011) The lesson of investigation. Pedagogical use of digital technologies for the teaching of Mathematics: From research to the classroom. Athens: Topos Publications, in Greek.

Tzimas, B. (2009). Teaching scenarios with the help of ICT. Proceedings of the 1st Educational Conference "Integration and use of ICT in the educational process". Retrieved 06 November 2022, in Greek, from https://www.etpe.gr/wp-content/uploads/pdfs/etpe1343.pdf

Web sources

https://omerad.msu.edu/teaching/teaching-skills-strategies/27-teaching/162-what-why-and-how-to-implement-a-flipped-classroom-model http://www.diapolis.auth.gr/epimorfotiko_uliko/index.php/2014-09-05-15-40-12/2014-09-05-16-28-22/97-odigos-dimitriadou?showall=1

Using inquiry-based learning techniques in physics teaching

Panagiotis Pefanis [(1)] , panpefgr@gmail.com

Konstantinos, Apostolopoulos [(2)], constantinos.apostolopoulos@gmail.com

[(1)] *Educational Coordinator for Science*

[(2)] *Educational Coordinator for Science*

Abstract

Two examples are described in which inquiry based teaching techniques are used based on the principles of the methodological approach of the inverted classroom. The first example emphasizes the need to confront alternative ideas through processes that facilitate cognitive conflict, while the second example uses the virtual laboratory without the need to confront alternative ideas. fFinally, we end up with a reference to the expected learning outcomes

Keywords: Flipped Classroom, Alternative ideas, Cognitive break, interaction, force.

1. Introduction

Teachers in modern classrooms should differentiate the educational content, process and products of learning. The aim of differentiation is to create a flexible environment that highlights and utilizes different interests, skills and learning profiles. The aim is to involve all students in processing information and interacting with new knowledge as well as to emphasize the development of science process skills.

We are therefore looking for a combination of tools for educational practice that can meet these requirements. As such, the proposed scenarios of the CONNECT project use the principles of inquiry-based teaching and differentiation supported by the methodology of the flipped classroom model.

According to these principles, the course is organized and conducted in three (3) Phases. During Phase A, students are provided with a variety of educational content (websites, texts, audio files, video files, photos etc.) for individual study which must:

a) focus on declarative knowledge so that the student can manage it on his/her own,

b) motivates students and boosts their interest for the teaching content,

c) relates to the designed inquiry activities of Phase B, which will be carried out by the students, in the classroom.

2. Application of the reversed classroom in science teaching

Knowledge is constructed by learners themselves whereas the process of constructing new knowledge begins with what is already known and takes place with internal cognitive processes that lead to the construction of mental models of how the real world works, which can be used to solve problems. Certain ideas that structure students' existing mental models lead to an inadequate or incorrect understanding of how the phenomena in question work in science. In other words, they refer to a kind of conceptual difficulty that the student encounters (Smyrnaiou, 2014).

Taking the above into account, we considered the students' alternative ideas to be a key element of the educational process.

When teaching a new module, it is necessary to assess whether these alternative ideas raise serious obstacles for many students and should be placed at the center of the educational process. In this case, inquiry based approach is one of the most appropriate teaching approaches to lead students to cognitive conflict and conceptual change. On the other hand, if these ideas do not come up a learning obstacle can be ignored. Thus,in phase A of the flipped classroom process, instead of giving students appropriate questions to elicit alternative ideas, we can instantly implement activities that trigger the discovery of new knowledge.

2.1 Example 1: Newton’s 3th Law

In the first example, which concerns Newton's third law, the inquiry based approach was preferred since it was considered that a cognitive conflict with alternative ideas such as the following was required:

Heavier objects fall faster than lighter ones.

Gravity is the tendency of bodies to fall to the ground. Therefore, gravity is not necessarily a force.

Forces act only in contact with bodies.

Objects of greater mass exert more force on objects of lesser mass than they receive from them.

Consequently, in the asynchronous phase preceding the face-to-face one, activities are used which reveal these ideas but at the same time challenge students to reflect on their correctness. Students are asked to carry out two activities relating to body interactions, in contact and remotely, which can be done using pictures or digital interactive applications.

Then, synchronously into the classroom or science laboratory, initially the students' alternative ideas that emerged in phase A are highlighted and linked to predictions, followed by group activities that include all the steps of scientific methodology (observation, formulating hypothesis, experimentation, discussion and drawing conclusions). The students then combine qualitative and quantitative investigation of the hypotheses, with experimental activities that can be implemented either in the laboratory or alternatively in an interactive simulation application. Activities are designed to provoke a cognitive conflict mainly with the last of the alternative ideas mentioned above. The synchronous phase concludes with the formulation of the final conclusions.

In phase C, which is asynchronous, the following activities are proposed that combine:

Evaluation with a short closed-type test.

Re-framing and extension with emphasis on applications of the third law that refer to contact and remote-distance forces.

2.2 Example 2: Coulomb's Law

The second example concerns Coulomb's law and it is based on three assumptions regarding what students already know:

In previous lessons they have clarified the existence of two kinds of electric charge and their interactions.

From previous classes I know Newton's third law.

They have not performed views on the quantitative component of electric force.

Consequently, through the activities of the initial asynchronous phase, both the assessment of prerequisite knowledge and its activation is attempted. In particular, students study the interaction phenomenon with simple experiments which can be done at home discovering the types of mutual force as well as the quantities on which it depends.

Then in the synchronous phase, the steps of the scientific method are followed. Definitely, it is preferable for this experimentation to be contacted via a virtual simulation experiment. The process focuses on the discovery of the quantitative relationships among the quantities on which the measure and direction of the electric force depends. Measurements are recorded in tables, diagrammes are requested that depict the relationship of force to loads and distance and the phase is completed with the formulation of the law verbally and mathematically.

For the asynchronous phase C, a short evaluation test is used.

3. Conclusion

The aforementioned practices are designed to have a strong inquiry dimension. The various activities can be dynamically shaped depending on whether and to what extent the teacher considers that the assumptions that have been made regarding alternative ideas are valid for the context of the class he/she has to teach. However, in any case, the activities should:

a) achieve a high degree of student engagement

b) develop soft skills such as collaboration, communication, discussion and reflection

c) foster science process skills such as observing, measuring, controlling variables, data processing (e.g. tables and diagrams), interpreting experimental data, etc.).

4. References

Angelidis, P. (2011). Pedagogies of inclusion. Zefyri: Interaction

Ali A. (2014). "The Effect of inquiry-based learning methods on students' academic achievement in science courses", *Universal Journal of Educational Research*, Vol. 2, No. 1, pp. 37-41.

Craft A. (2003). "The limits to creativity to education: dilemmas for the educator", *The Open University British Journal of Education Studies*, Vol. 51, No. 2, pp. 113-127.

Driver, R., Squires, A., Rushworth P., & Wood-Robinson, V. (1998).

Constructing the Concepts of Natural Sciences. Athens Typothito G. Dardanos.

Gábor H. and Alain M. Key (2011). "Competences in Europe: Interpretation, policy formulation and implementation", *European Journal of Education*, Vol. 46, No. 3, pp. 289-306.

Galindo-Dominguez, H. (2021). Flipped Classroom in the Educational System: Trend or Effective Pedagogical Model Compared to Other Methodologies? *Educational Technology & Society*, *24* (3), 44–60.

Minstrel J. and van Zee E. H. (2000). *Inquiring into Inquiry Learning and Teaching in Science*, Washington: American Association for the Advancement of Science.

Skoumios M. (2012) Applied Didactics of Natural Sciences. Ed. University of the Aegean, Rhodes

Smyrnaiou, Z. (2014). Alternative Ideas or Misconceptions of Students.

Challenges and Practices in the instruction of Mathematics

Kyriakos Kampoukos, kkamp@math.uoa.gr

Educational Coordinator for Mathematics

Abstract

In the core of mathematical instruction there are two major questions: What does it mean to “think mathematically”? How can we help students to do it? In the present work, we try to address the above questions discussing the issue of characteristics of the mathematical classroom that support students’ development as powerful mathematical thinkers.

Keywords: mathematical instruction, powerful thinkers, understanding, practices, challenges

1. Introduction

For generations, school students have studied mathematics in a way that has very little to do with the way mathematics is created. One reason for this is that mathematics courses are seen as mechanisms for communicating established results and methods. Students learn some properties, work on some problems in which they apply these properties, and go on. The contexts in which they work might be more modern, but the methods they use are far from mathematics.

A mathematics course must definitely encompass the results of mathematical thinking, but much more important than specific mathematical results are the habits of mind used by the people who create those results. (Cuoco et al., 1996) The point is to help students learn and adopt some of the ways that mathematicians use such as describing, visualizing, guessing, conjecturing, making connections, inventing and arguing, giving them a genuine research experience.

2. Approach

Instruction can be considered successful when knowledgeable, flexible, and resourceful thinkers and problem solvers have emerged from it.

What really matters in mathematical classrooms?

What are the attributes of learning environments from which students emerge as powerful thinkers?

What personal, social, and institutional understandings and proficiencies should teachers have in order to create environments with such characteristics?

Is it possible to identify a small number of well-defined dimensions of classroom practice, such that classrooms that do well on those dimensions produce students who are really good mathematical thinkers and problem solvers?

3. Results

Research indicates that five dimensions of classrooms practice are essential: (Dimension 1) The richness of the disciplinary content and practices; (Dimension 2) cognitive demand or the opportunity for students to engage in what has been called “productive struggle”; (Dimension

3) equitable access to core content and practices for all students; (Dimension 4) opportunities to develop a sense of agency, to make the mathematics their own and to develop productive mathematical identities; and (Dimension 5) formative assessment, the degree to which student ideas are made public and responded to in productive ways; (Schoenfeld, 2020:1171)

These five dimensions, in the mathematical sense, are necessary and sufficient to characterize powerful learning environments. They distill what has been found in the literature to be important about learning environments (Schoenfeld, 2019:361)

4. Discussion

Dimension 1 concerns the content and the practices in which the students are involved. It is clear that the more the curriculum or teacher provides meaningful access to richer mathematics, the greater the opportunities students have to emerge from the classroom as powerful mathematical thinkers. Mathematical creativity does not occur in a vacuum. In the center of instruction must be the big ideas, the general picture. It is significant to build curricula that would support teachers in introducing students to mathematically important content and powerful modes of mathematical thinking. Focus on details may lead to the loss of the big picture; we may lose the forest for the trees. In the center of instruction must be the big ideas; the details follow. A big idea is defined by Charles (2005:10) as “a statement of an idea that is central to the learning of mathematics, one that links numerous mathematical understandings into a coherent whole” . The real benefit of considering big ideas is that it engages teachers in a deeper discussion of the mathematics they are teaching, making it more likely that they will look for connections and press for understanding (Clarke et al., 2012). The concept of big ideas is powerful because it assists teachers in developing a coherent overview of mathematics. But more importantly it enables students to develop a deeper understanding of mathematics and its interconnectedness, both within the world of mathematics and between the world of mathematics and the real world. (Tout & Spithill, 2015:19)

It is widely recognized that learning with understanding is maximized when students have the opportunity to make connections within a specific area of mathematics, between different areas of mathematics, and between mathematics and their real lives (Freudenthal, 1973; Tout & Spithill, 2015; Watson et al., 2013). Students learn more and retain more of what they have learnt when it is connected to a network of related ideas and experiences (Caine & Caine, 1991; Charles, 2005; National Research Council, 2000). A focus on big ideas means focusing on connections, which once acquired increases the likelihood that the new learning will be applied to other situations. Historically, Whitehead (1913) suggested that school mathematics should emphasize main universally significant general ideas rather than focusing on details that may not lead to access to big ideas or provide necessary connections to everyday knowledge.

Dimension 2 concerns the extent to which the environment provides students with opportunities for sense making and for what has been called “productive struggle”. Students’ persistence is a major challenge for teachers; “We can’t get our students to persist. If they don’t have a method at hand, if they don’t know what to do, they tend to give up. In other words, “How do I get students to work harder?”

But why would a student persist? Basically, persistence is a question of agency. If a student has developed a sense of agency (the belief that if they work hard they will make progress), then, it is likely to try doing so. The sense of agency does not come from doing simple exercises, which cannot be considered meaningful. Furthermore, it does not come from being unsuccessful at tasks that are inaccessible or from being told what to do when you get stuck. It comes from making progress on problems that one considers meaningful challenges. Characteristics of good problems that are instructionally useful are described in Schoenfeld, 1991.

So, the question is “what is within reach?” Needless to say, finding the right level of challenge for students is difficult. Effective instruction is designed in such a way that it can meet the students where they are and help them grow from there. That’s the issue of cognitive demand. A teacher will use formative assessment to help set the right level of cognitive demand.

Dimension 3, “equitable access”, has to do with the participation in the mathematical activities of the classroom. Who participates and how?

What is the desirable purpose? To identify and support exceptional talented students in mathematics or to provide access to all students to powerful mathematics? In the context of public education every student should have the opportunity to engage with the core content in meaningful ways. Potential modes of engagement include talking, writing, listening, paraphrasing, manipulating symbols, making diagrammes, interpreting, conjecturing, generating examples and counterexamples and connecting different ideas.

At school, we would like all students to experience mathematics in a way to acquire:

Some useful general habits of mind.

Some mathematical approaches that have proved themselves worthwhile over the years (Cuoco et al. 1996).

Dimension 4 “agency, ownership and identity” concerns the issue of mathematical identity that a person creates for himself. How do students come to view themselves as thinkers and doers of mathematics? What opportunities does the classroom environment provide for students to come to see themselves as people who can do and explain mathematics?

School students should be able to use the research techniques that have been so productive in mathematics, and they should be able to develop conjectures and provide supporting evidence for them. When asked to describe mathematics, they should say something like “It’s about ways for solving problems” instead of “It’s about triangles” or “solving equations” or “doing percent” (Cuoco et al., 1996).

We must keep in mind that there is not a unique way to understand and to do mathematics. Writing in the first decade of the twentieth century Henry Poincare asserted that “it is impossible to study the works of the great mathematicians or even those of the lesser, without noticing and distinguishing two opposite tendencies, or rather two entirely different kinds of minds (Poincaré 1913). In an effort to support his arguments by contrasting it to the work of various mathematicians, Weierstrass and Riemann included, relating this to the work of students: “Weierstrass leads everything to the consideration of series and their analytic considerations; to express this better, he reduces analysis to a prolongation of arithmetic; you may turn through all his books without finding a figure. Riemann, on the contrary, at once calls geometry to his end; each of his conceptions is an image that no one can forget, once he has caught its meaning… Among our students we have the same differences; some prefer to treat their problems “by analysis” others “by geometry”. The first are incapable of “seeing the space” the others are tired of long calculations and become perplexed (Poincaré, 1913).

Undoubtedly, there are not only two different kinds of mathematical minds but many. Teachers should be aware that their personal view of mathematics may differ from the conceptions of the others. No one view holds universal sway. (Tall, 1991 p.6)

Dimension 5. The key question in this dimension is: What does a teacher know about each student's current mathematical thinking, and how can he build on it? Formative assessment could be defined as "all those activities undertaken by teachers, and by their students in assessing themselves, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged. Such assessment becomes "formative assessment" when the evidence is actually used to adapt the teaching work to meet the needs of students." (Black and Wiliam, 1998:91). Powerful instruction "meets students where they are" and gives them opportunities to move forward. A fundamental way to know students' ideas and misconceptions is making students express themselves publicly. Moreover, students should be given the possibility to remedy a misconception.

A focus on big ideas is the easy part compared to the other dimensions. Issues related to cognitive demand, equity access, formative assessment, agency and identity are more complicated (Schoenfeld, 2020).

5. Conclusion

As mentioned above, organizing a course around the ways of thinking rather than around the results another benefit is derived. To this end, we must try to create, through appropriate problems, learning environments where:

Mathematics are experienced as a discipline of exploration

Key ideas of mathematics are in the center of instruction

Students feel safe to express their ideas and are considered as being capable and able to contribute

Student thinking is central to classroom discourse.

6. References

Black, P. J., & Wiliam, D., (1998). *Assessment and classroom learning*. Assessment in Education. 5, 7–74.

Caine, R. & Caine, G. (1999). *Making connections: Teaching and the human brain*. Association for Supervision and Curriculum Development.

Charles, R. (2005). *Big ideas and understandings as the foundation for elementary and middle school mathematics*. Journal of Education Leadership, 7(3), 9-24.

Clarke, D., M. Clarke, D.J., & Sullivan, P. (2012). *Important ideas in mathematics: What are they and where do they come from?* Australian Primary Mathematics Classroom, 17(3), 13-18.

Cuoco, A., Goldenberg, E. P., & Mark, J. (1996*), Habits of mind: An organizing principle for mathematics curricula,* Journal of Mathematical Behavior, 15, 375–402.

Freudenthal, H. (1973), Mathematics as an educational task. D. Reidel Publishing.

National Council of Teachers of Mathematics, (2000), *Principles and standards for school mathematics*. NCTM.

Poincaré, H. (1913), *The Foundations of modern Science*, The science press, New York.

Schoenfeld, A. H. (1991) What's all the fuss about problem solving? *Zentrallblatt fur didaktik der mathematik,* 91(1), 4-8.

Schoenfeld, A. H (2019), *Reframing teacher knowledge: A research and development agenda*. ZDM: Mathematics Education.

Schoenfeld, A. H. (2020), *Mathematical practices, in theory and practice*. ZDM: Mathematics Education.

Tall, D. (1991) *Advanced Mathematical Thinking*, Kluwer Academic Publishers.

Tout, D & Spithill, J, (2015), Big ideas in Mathematics Teaching, The Research Digest, (11).

Watson, A., Jones, K. & Pratt, D. (2013). *Key ideas in teaching mathematics: Research-based guidance for ages 9-19.* Oxford University Press.

Whitehead AN, (1913), *The mathematical curriculum*. Math Gaz 7:87–94.

Flipped Classroom scenarios for English as a Foreign Language in the context of Erasmus+ KA2 "CONNECT" project

Eleni Zografou, zgrfel@gmail.com

English Language teacher, Msc. 1st Primary School of Koropi

Abstract

The article presents the philosophy and structure of the eight educational scenarios for English as a Foreign Language which were developed in the context of the Erasmus+ KA2 *"**CONNECT**"* project. The educational scenarios are based on the blended learning teaching model with a focus on the Flipped Classroom approach as a differentiated strategy for teaching and learning, which can provide students with the space for self-directed learning and critical thinking as well as teachers with opportunities to elaborate online techniques in their teaching practice. The results entail the four-stage structure and the flow of actions undertaken by the teacher. The discussion provides some tips for more efficient implementation of this approach, taking into account the class dynamics. In conclusions, links are presented between the approach and the students' skills' enhancement, necessary for self-improvement and empowerment against the challenges of contemporary societies.

Keywords: Educational scenarios, Flipped classroom structure, Learning Cycles, self –directed learning, collaborative learning

Introduction

The article presents the philosophy, principles and structure of the eight educational scenarios for English as a Foreign Language which were developed by secondary school teachers of the three partner countries (CY, GR, IT) involved in an Erasmus+ KA2 project under the title *"**CONNECT** - Upskilling of s**C**hools' teachers to effectively support **ON**li**N**e **E**du**C**a**T**ion",* coordinated by the RDPSEA[3]. The blended learning teaching model combines face-to-face and distance learning and has effectively responded to the recent Covid-19 restrictions. The Flipped Classroom approach, paired up with ICT, provides a more student-centered approach to learning with the teacher "on the side", whereby students are presented with digital material before class (asynchronous stage) and spend the actual in-class lass time (synchronous stage) with collaborative activities promoting critical thinking and reflection. The last asynchronous stage, following in-class activities, provides students with opportunities to create either independently or collaboratively and evaluate their own learning.

[3] Erasmus+KA2 CONNECT project aims at reinforcing EU secondary school teachers to provide high quality and inclusive online education. The consortium partners are: the Regional Directorate for Primary and Secondary Education of Attica (RDPSEA), the Computer Technology Institute and Press "Diophantus" from Greece, the Institute for Educational Technology (CNR-ITD) in Italy, and the University of Cyprus (UCY) https://connect-erasmusproject.eu/index.php/en/

CONNECT Approach

Since teaching is much more than good content delivery, differentiated strategies for teaching and learning aim at engaging all students in collaborative learning and provide an autonomy in the way/s they learn. Such a differentiated strategy is the Flipped classroom, which is a complementary approach to in-class instruction. Based on the blended learning method, "Flipped Learning" is a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter." (Flipped Learning Network definition).

2.1 The Flipped classroom approach in CONNECT scenarios

The Flipped classroom approach fosters self-directed learning as students are exposed to knowledge before coming to class and are more prepared to engage in discussions and application of the "new" knowledge through collaboration (Hamdan & McKnight, 2013). Bloom's taxonomy (Bloom et al., 1956) serves as the backbone to move the teaching process towards developing skills rather than delivering content. The emphasis on higher-order thinking skills is based on the topmost levels of the taxonomy, including analysis, evaluation, synthesis and creation.

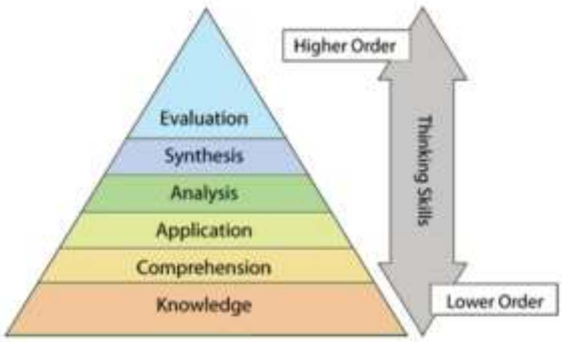


Figure 1: The target classification pyramid by Bloom

Anderson et al (2001), revised the Bloom's Taxonomy interrelating knowledge with the cognitive processes students use to gain and work with knowledge and focused on learning outcomes, which require action through each level in order: students need to understand a concept in order to remember it, to apply it in order to understand it and so on.

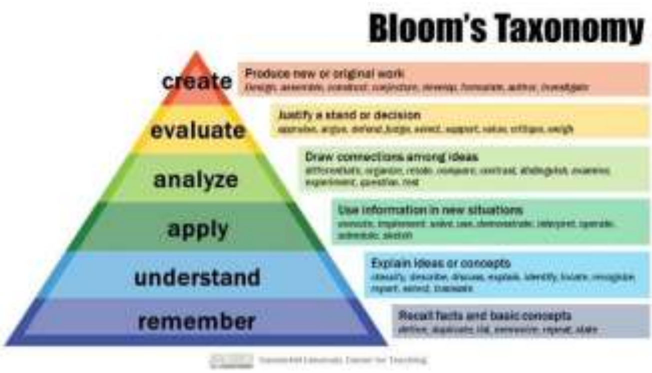


Figure 2: Revised Bloom's Taxonomy, Anderson et al

Source: https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy

Churches (2008), further developed Bloom's Taxonomy to create Bloom's Digital Taxonomy, a taxonomy more aligned with 21st century learning, which "*is not restricted to the cognitive domain rather it contains cognitive elements as well as methods and tooling…. An increasing influence on learning is the impact of collaboration in its various forms. These are often facilitated by digital media and are increasingly a feature of our digital classrooms*". Through ICT, there is a shift from teacher-centered learning to student-centered learning, and a change in the role of the teacher from a 'knowledge provider' to a 'knowledge resource' due to "*self-access to information*", a key feature of technology (Trebbi, 2011).

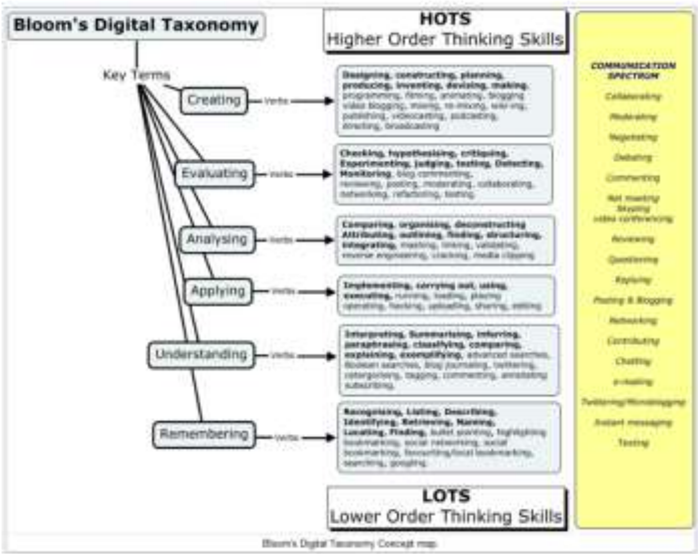


Figure 3: Bloom's Digital Taxonomy

Source: http://ictliteracyforthemiddleyears.weebly.com/blooms-digital-taxonomy.html

Based on the above, we conclude that this shifting can help students to reflect on, to analyze, and evaluate what they learn, in a communication environment, and finally to design and create their own learning. This facilitates the development of higher order skills (Hutchings & Quinney, 2015). In A Review of Flipped Learning (Hamdan & McKnight, 2013), the authors acknowledge that flipped classrooms can differ in methods and strategies, largely due to the fact that "learning focuses on meeting individual student learning needs as opposed to a set methodology with a clear set of rules".

In any case, the Flipped Classroom Learning pre-supposes: a flexible environment, a learning culture; an intentional content; and a professional educator[4]. The use of ICT and the inverted roles between the teacher and the student/s are both closely linked to the Flipped Classroom

4 Flipped Learning Network (FLN) (2014). The Four Pillars of F-L-I-P. www.flippedlearning.org/definition

With the support of the Erasmus+ Programme of the European Union
CONNECT - Upskilling of sChools' teachers to effectively support ONliNe EduCaTion
KA2 - Agreement Number : 2020-1-EL01-KA226-SCH-094578

Approach. By using structured and targeted ICT tools before, during and after class-instruction, students can finish the lower level of cognitive work before class; when they come to class, they can engage in higher cognitive learning levels and collaborative skills with peers and teachers present.

All CONNECT educational scenarios follow this approach, which aim at enhancing students' higher-order skills. During the first Asynchronous stage -before In-class instruction-, the students take responsibility for gathering information about what is going to be taught in class, so that they will be able to further elaborate and construct, analyze and synthesize, create and evaluate, and finally draw own conclusions, in groups, in pairs or individually, as and when necessary (Synchronous/Face-to-face stage and the second Asynchronous stage).

2.2 The Flipped Classroom structured educational scenarios

The CONNECT educational scenarios share a common structured process, involving "cycles of learning" and a sequence of teaching units which require a defined timeframe and a logical process to be followed. The actual teaching/learning process involves: Distance learning - Face-to-face learning – Distance learning (asynchronous- synchronous - asynchronous learning), which takes turns, with the use of ICT being at the core. The flow of actions in a Flipped way is as following:

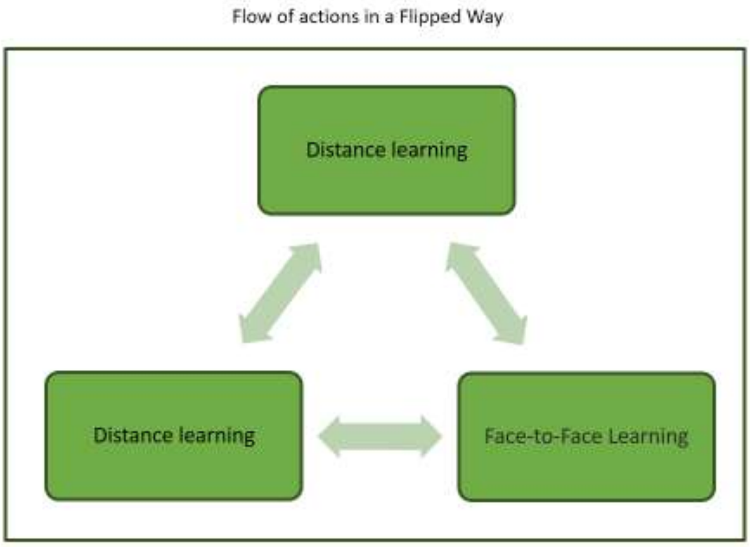


Figure 4: Flipped Classroom Three-stage Sequence of Actions

All CONNECT educational scenarios for English share the following common characteristics:

-Involve a general teaching aim and specific objectives, closely linked to the aim.

-Involve pre-class, in-class and after-class activities

-Are designed as stand-alone teaching units based on the curriculum or teaching units linked with any contemporary, challenging, or triggering issue that may arise in class

-Include activities that encourage students to exercise collaboration and critical thinking;

-"Reflect and react" are core skills for students to develop;

-Involve non-formal methodology techniques and experiential learning;

-Integrate appropriate ICT tools, at all phases;

-Encourage discussions, group activities, group assignments, readings and individual work;

-Promote interdisciplinary knowledge and skills;

-Involve self-directed learning through exposure to new knowledge beforehand;

-Enhance peer-to-peer learning and

-Highlight self-evaluation and a critical overview so that students comprehend what is beyond their own knowledge and teachers realize what they can do to improve their teaching.

In addition, ICT tools' integration has highly contributed and has also changed the roles of the teacher and the students. Thus, the CONNECT Educational scenarios reflect:

A.In Distance/Asynchronous learning:

-the teacher's online role as guide and

-the students' online engagement for autonomous/self-directed learning (first asynchronous) or collaborative learning (second asynchronous)

B. In Face-to-face/Synchronous learning:

-the role of the teacher as mediator and knowledge consolidator and

-the students' role as active learners and "creative thinkers"

The three-stage sequence of actions mentioned above, requires relevant planning and preparation beforehand, as well as reflection at the end of the process. Thus, the CONNECT Educational Scenarios for English have a common template which involves a four-stage structure: Planning; Preparation; Flipped Classroom actions; Reflection & Evaluation, as presented below:

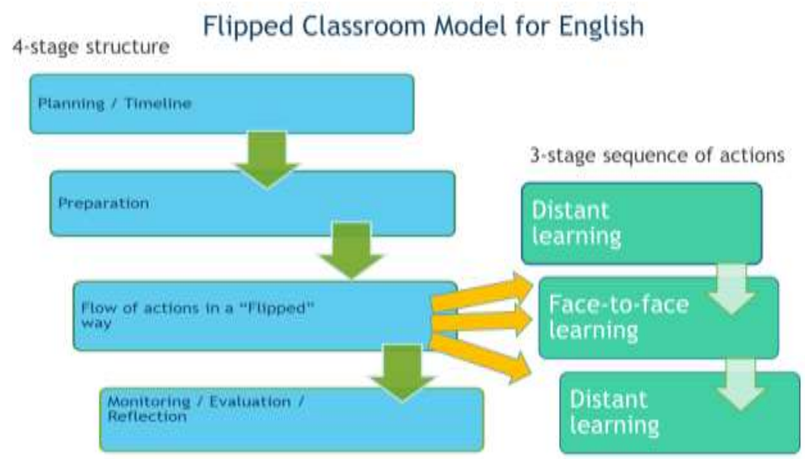


Figure 5: Flipped Classroom Model as a four-stage Structure

Results

All CONNECT educational scenarios have a common template which reflects the four-stage structure. At the core of this template is the general teaching/instructional aim and the objectives, determined by the teacher beforehand, which are closely linked to the learning outcomes and what the teacher is expecting students to acquire and create. Ideally, the instructional goal should be summarized in a single sentence and the learning outcomes should be related and guided by this goal.

3.1 Stage 1: Planning the Flipped Classroom Educational Scenarios for English

Teachers need to plan and prepare their own activities and their students´ activities according to a three stage sequence, as mentioned above: “before the class“, “during the class” and “after the class”. When applying the Flipped Classroom approach, it is necessary for the English Language teacher and any Foreign Language teacher to reflect about teaching and learning strategies; it is necessary to consider the students’ knowledge background and maturity, their foreign language level, their age group and learning preferences, before s/he decides on the aims and objectives of a potential Flipped scenario. Teachers should also take into account class dynamics so that they organize group activities in the best possible way, since not all students have the same mode of learning or the same level of knowledge. They may link the educational scenario to the Curriculum or to any concept/issue which is relevant to the class. In any case, the teacher needs to consider the pre-existing knowledge and background of the students before planning any educational scenario.

When preparing and deciding about the concept of an educational scenario, the teacher thinks about issues and topics that will be relevant and supportive for all students, challenging or controversial issues, concepts, knowledge, and skills which are key subjects to the discipline of English language. The teacher may also choose non-traditional or traditional topics which are approached in an alternative way. Universal topics are also an opportunity for developing educational scenarios. For example, the concept of law or democracy is inherent in school textbooks. How does this show in the classroom and in practice? The issue of "diversity" is a sensitive social issue, "non-traditional". How can we "teach" it? A theorem in mathematics or a grammatical phenomenon in the English language is traditional and sometimes boring and incomprehensible. How can this be presented in an attractive way?

Planning Educational Scenarios can be illustrated as follows:

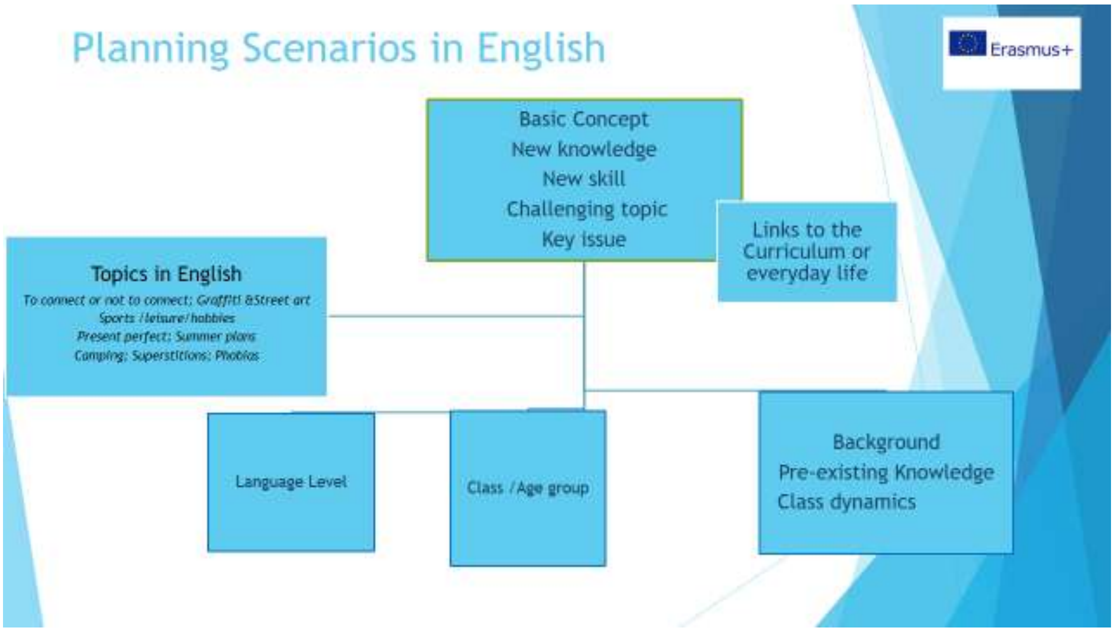


Figure 6: Stage 1- Planning the Flipped Classroom Scenarios for English

The CONNECT educational Scenarios for English are focused on the following topics, which are either linked to the high school curriculum or are connected to the interests and needs of the students. In any case, they are inter-disciplinary and focus on phenomena of English language and/or a combination of vocabulary and grammar concepts with close links to everyday life and/or students' concerns and interests:

To connect or not to connect

Graffiti & Street art

Sports /leisure/hobbies

Present perfect

Summer plans

Camping

Superstitions

Phobias

Stage 2: Preparing the Flipped Classroom Scenarios for English

The teacher sets one core aim and 2-3 (maximum) number of realistic objectives related to what s/he expects students to acquire through the Flipped process. Each educational scenario is based on the pre-existing knowledge background of students: what they already know, what they understand and how far they can go. So, the teacher may reflect on the following:

What do I want students to learn?

What do I want them to understand and to be able to do at the end of class?

What do I want them to get out of this scenario?

What are the most important concepts/ideas/skills I want students to be able to grasp?

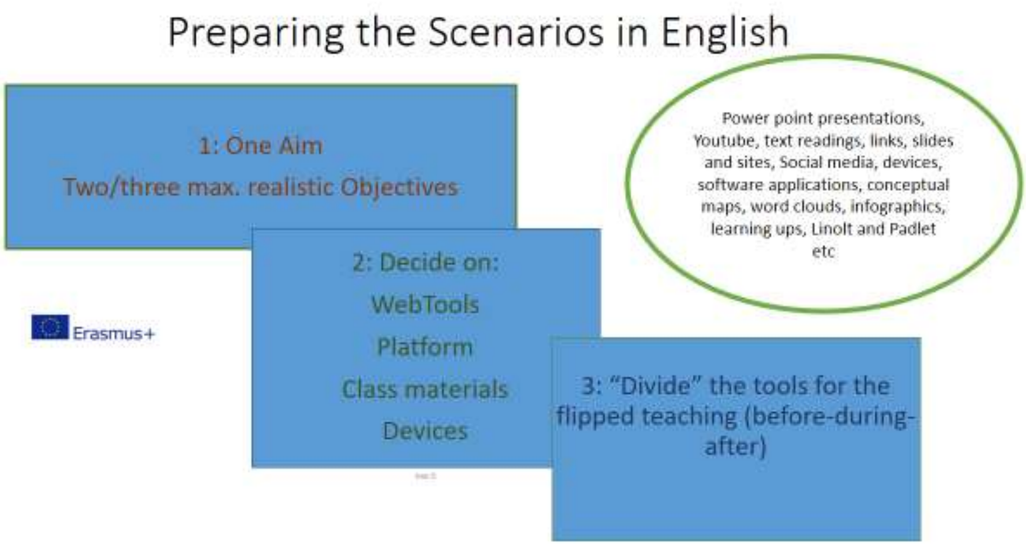


Figure 7: Stage 2 - Preparing the Flipped Classroom Scenarios for English

As we can see in the Figure above, after the teacher decides on the aim and the objectives s/he links them to the learning platform to be used for communication, teaching and learning. The teacher also needs to decide about the web tools which are delivered in the three-stage sequence of flipped actions; powerpoint presentations, Youtube, readings, links, slides and sites, Social media, devices, software applications, conceptual maps, word clouds, infographics, learning ups, Linolt and Padlet for online collaboration etc are among the web tools which can be used within this process. Finally, the teacher decides about the class materials and devices necessary for face-to-face teaching.

Videos are an essential tool to be used inside and outside the classroom (both synchronous and asynchronous learning). It is important that the videos are short with the appropriate format according to the learning objectives. It is more efficient to present multiple short videos rather than one long video; it better aligns with the students' attention and is more compatible to give instructions to students. In case the teacher makes her/his own video, it is recommended to divide the topic into blocks and make different videos of no more than 10 minutes on each of them, always trying to deal with a different theme in each block. The teacher may also complement videos with guiding questions, interactive elements, or reflective components to make the process more appealing.

Stage 3: Flow of teaching and learning in a Flipped way

Following relevant planning and preparation, the teaching learning process involves the structure: Asynchronous-Synchronous-Asynchronous. During the Asynchronous stage, all educational scenarios for English present a video, an image, screencasts, video and audio recordings or a ppt which describes the process in detail. It is recommended that the videos are engaging and clear. The teacher provides simple instructions and also explains that the video's content will be discussed in class. The online role of the teacher in this case lies in the creation or sourcing of a series of media to facilitate self-directed learning at the student's own pace. As also included in the CONNECT educational scenarios, at this stage videos are accompanied with other webtools, which can be considered as some kind of "assessment" related to the pre-class material in order to ensure students' understanding.

In the Synchronous stage, the most important issue is that activities are to provide students with opportunities to deepen understanding. It involves techniques and strategies that encourage the students' active participation, such as: project learning, autonomous learning, cooperative learning, dialogical learning or gamification. The teacher's role here is to conduct a series of experiential learning exercises in the classroom and to ensure that students receive practical and appropriate guidance. By providing clear instructions each time, the teacher activates students, who can work in pairs, in groups, with the whole group or individually. The work can be simultaneous or sequential, depending on what the teacher wants to accomplish; actually, the work aims at focusing students to attain higher-level cognitive abilities. In any case, the CONNECT educational scenarios have applied the following common communication strategies:

Concepts are applied in class;

When working on small issues, peer instruction in pairs or small groups is more efficient;

When working on bigger concepts, Discussions and Debate strategies are more efficient in larger groups;

Whole class reflection is necessary for consolidation.

Finally, in the final Asynchronous stage, the educational scenarios have applied a variety of methods. Traditional evaluation methods usually compare students to each other and hardly provide opportunities for reflection (ie. assign content for Homework, e- assignments for scoring/grades). On the other hand, the educational scenarios also include methods supporting student-centered assessment (i.e self-assessment, assessment by peers, evaluation of project work, cooperative work, portfolio, self-evaluation reports, and study logs).

It can be claimed that all educational scenarios, either in Face-to-Face or in Asynchronous learning, support the basic objective of the assessment, which is to improve the quality of students' learning and to enhance their skills, irrespective of grading and scores. As there are more opportunities for interaction in face-to-phase learning, the teacher can have immediate feedback about students' understanding. Online tools (like Kahoot) can sufficiently contribute towards this direction. The teacher, as evident in the educational scenarios, may provide students with assignments that activate students: students may do field research, find online resources, work collectively or independently, ask each other and present the result of their common effort on the platform or elsewhere.

Stage 4: Reflection

The CONNECT educational scenarios are to be piloted during January-March 2023 in Italy, Cyprus and Greece. Stage 4, which is reflected in section 5 of the template is an equally important phase for the teachers to reflect on their own teaching. Piloting educational scenarios will provide valuable insights on the effectiveness of the approach, which can be integrated in section 5. Collecting feedback from students and taking into account the class response, teachers can improve their teaching techniques and consider potential critical incidents as an opportunity to change some of their teaching practices. Not all incidents are critical. Especially in the case of language learning, Finch (2010) argues that learning is a complex, multi-level and ever-evolving process which might be interrupted, slowed down or accelerated by various factors. In any case, critical incidents in teaching is for everyone concerned with the development of professionalism in teaching (Trebbi, 2011).

Discussion

It should be noted that the flipped classroom approach is a differentiated strategy for learning which provides opportunities for both independent and collaborative learning with the use of ICT. At the same time, English language is a suitable subject to flip the classroom - in most cases in an interdisciplinary way. It is at the teacher's disposal if, when and how to use the flipped classroom. In any case, online resources, e-tools and in-class activities must be targeted and purposeful. Otherwise, the flipped classroom approach may not be applicable or may not facilitate learning.

Flipping does not necessarily mean to use the latest technology! Many simple ICT activities can lead to the flipped classroom model and motivate students to learn.

Pre-existing knowledge and skills are both necessary in the flipped classroom approach. The teacher should gradually invite students in in-class activities such as discussion, debate, collaboration, etc, as these strategies are challenging for students and at times frustrating for less experienced and less talkative students. To this end, the teacher must be aware of class dynamics and must organize activities accordingly, encouraging all students to participate.

Not all students in the flipped classroom have the same performance, are equally active or enhance the same skills and knowledge at the same pace. Thus, the educational scenarios may not fit all students in the same way. The Asynchronous phase, before in-class teaching, provides an opportunity for students to work at their own pace, in their own space, thus increasing their potential active participation in class.

In all phases, the role of the teacher as moderator, guide and instructor is irreplaceable. In a flipped classroom, the teacher facilitates knowledge learning and collaboration. At home, students watch teacher instructions using different digital tools and videos and complete reading or some other type of learning activity. In both cases, the teacher is "present", either physical or online.

Conclusion

The flipped classroom can certainly contribute to students' engagement and can also promote quality in learning and teaching. Students exposed to flipped classroom opportunities are more likely to be interested in what is taught at school, especially when this is related to everyday life, their interests and knowledge as well as contemporary challenges. After all, knowledge is easily accessible today and students are quite familiar with that. Skills and competences like collaboration, critical thinking and independent learning, flourished through the flipped classroom learning procedure, are more than necessary in today's communities, lifestyles and professions.

References

Anderson, L.W., and D. Krathwohl (Eds.) (2001). A Taxonomy for Learning, Teaching and Assessing: a Revision of Bloom's Taxonomy of Educational Objectives. Longman, New York.

Bloom, B.S. (Ed.). Engelhart, M.D., Furst, E.J., Hill, W.H., Krathwohl, D.R. (1956). *Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain.* New York: David McKay Co

Churches, A., (2008). *Bloom's Digital Taxonomy*. Retrieved from https://www.researchgate.net/publication/228381038_Bloom's_Digital_Taxonomy

Finch, A. (2010). Critical incidents and language learning: Sensitivity to initial conditions. In *System*, Volume 38(3), pp. 422-431.

Hamdan, N., McKnight, P., McKnight, K., & Arfstrom, K. M. (2013). The flipped learning model: A white paper based on the literature review titled a review of flipped learning. Flipped Learning Network/Pearson/George Mason University.

Hutchings, M., & Quinney, A. (2015). The flipped classroom, disruptive pedagogies, enabling technologies and wicked problems: Responding to "the bomb in the basement." Electronic Journal of E-Learning, 13(2), 105–118.

Trebbi, T. (2011). The potential of ICT for a new educational paradigm: Toward generalizing access to knowledge. *American Journal of Distance Education, 25*(3): 152– 161.

Tripp, D., (2012). Critical Incidents in Teaching (Classic Edition) Developing professional judgment. Routledge

CONNECTing and Collaborating to promote learning

Eftihia Papahristou , e.papahristou@gmail.com

Educational Coordinator of English as a Foreign Language

Abstract

This review paper aims to shed light on the importance of implementing collaborative learning, which is a teaching and learning approach that requires groups of students to work together in order to complete an assigned task by the teacher. It starts with providing a number of definitions of collaborative learning and continues with drawing a distinction between the confusing concepts of collaboration and cooperation. Then the characteristics and the benefits of collaborative learning are presented and discussed. Emphasis is also put on the teacher's and the students' role while adopting this approach in the English language classroom and at the end the relation of collaborative learning to the CONNECT approach is presented stressing the fact that they both result in promoting and fostering learning.

Keywords: Collaborative Learning, characteristics, benefits, teacher's and students' role, CONNECT approach, promoting learning

1. Introduction

Collaborative learning has lately drawn the attention of the educational community due to its key role in fostering an interactive learning environment for students. In particular, the need for collaboration amongst learners arises as an imperative need in the present era in a complicated classroom and is suggested to be more and more essential. Therefore, it is crucial to understand in depth the dynamics of collaboration as well as the extent to which it can positively affect the teaching and learning process per se.

Collaboration entails an attitude of communicating with other people requiring individuals to be responsible for their own actions in order to solve a problem. Collaboration is a "coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem" (Rochelle & Teasley, 1995). It involves individuals in the process of learning to respect the abilities of others as well as respecting their support to the completion of a specific task. In all circumstances where people have to work together in groups, it is compulsory to consider other group members in such a way which respects their individual skills and talents leaving ample space to highlight their contributions. Inexorably, there should be a sense of sharing of authority, power and expertise while working collaboratively. In this case, then, apart from accepting accountability of one's own actions, the implication these actions would have to all group members would also be considered.

Rowse & Emerson (2016) support that "collaboration is a key facilitator of cognitive development in early childhood; knowing which factors influence cognitive development during collaborative exercises for young children has implications for educators in terms of academic outcomes and well-being". Learning to collaborate, then, has its roots in early childhood whereas learning to interact can have a substantial, positive effect in one's cognitive development.

From the aforementioned, it can be drawn that forming an attitude of developing a learning environment which can promote collaboration and interaction amongst students is pivotal in the 21st century. In fact, collaborative learning has long been a teaching approach in the English language classroom in which learners are required to accomplish a task getting involved actively in their group sharing with their classmates a common goal (Arta, 2018). It is true that, only under this case, can learning be meaningful to students. Only when the teaching and learning process is attuned to the needs, goals and strengths of a learner, “students are not passively absorbing information, but are actively involved in constructing meaning from their experiences and prior knowledge. Rather than just receiving more information, the learner must make sense of the information with the help of his/her learning community” (Stein et al, 1994). Collaborative learning is a teaching method developed for over 40 years, and its effects on various areas such as student success, attitude to learning, and motivation are proven by research. “Over the last decades, research has demonstrated that collaborative learning can promote academic and social educational outcomes (Johnson, Johnson, & Smith, 2007; Slavin, 1996 in Le, Janssen & Wubbels, 2016)”.

1.1. Defining Collaborative Learning

In the context of education, Collaborative learning is one of the most widespread and prolific areas of theory, research, and practice. Laal & Ghodsi, (2011) state that “the underlying premise of collaborative learning is based upon consensus building through cooperation by group members, in contrast to competition in which individuals best other group members”. Group members, consequently, should consider their classmates as equal, accepting others opinions and points of view since there is no space for competitiveness in order to reach a common learning goal. Berry (1991) argues that collaborative learning may be distinguished from other forms of group work since “collaborative learning organizes students not only to work together on a common project; but, more importantly, to engage in a process of intellectual negotiation and collective decision making thus, reaching consensus through an expanding conversation”. Additionally, he eloquently clarifies that one of the aims of collaborative learning is that the learners reach consensus, which ultimately entails “the capacity for self-organization, cooperation and common action”. The latter, actually, enables individuals to participate actively and meaningfully in group endeavors.

According to Smith & MacGregor (1992), “Collaborative learning” is an umbrella term for a variety of educational approaches involving joint intellectual effort by students, or students and teachers together. Usually, students are working in groups of two or more, mutually searching for understanding, solutions, or meanings, or creating a product. Collaborative learning activities vary widely, but most center on students’ exploration or application of the course material, not simply the teacher’s presentation or explanation of it”. In fact, this definition includes a number of different factors involved in collaborative learning, i.e. the teacher, the students, the learning activities, the learning material, the way students work as well as the teacher’s role in implementing the collaborative learning approach.

Johnson & Johnson (1999) claim that collaborative learning can be defined as “a set of teaching and learning strategies promoting student collaboration in small groups (two to five students) in order to optimize their own and each other’s learning”. Slavin (1980) defines it as "classroom techniques in which students work on learning activities in small groups and receive rewards or recognition based on their group's performance." This definition adds the issue of being rewarded for the joint effort, which may act as a motivating factor for the group members.

According to Macaro (1997), collaborative learning is a process in which students collaborate together to achieve ‘common learning goals’, hence, implying that classroom organization is established in such a way that students work in pairs or groups rather than working individually. Therefore, emphasis is put on the fact that shared learning goals must be achieved through implementing specific tasks and activities for this reason. Cohen (1994) has a more or less similar attitude defining collaborative learning as “students working together in a group small enough that everyone can participate on a collective task that has been clearly assigned. Moreover, students are expected to carry out their task without direct and immediate supervision of the teacher”. The latter suggests that students are self-regulated and can organize their work making decisions on their own for the process of successfully completing the task assigned to them.

Kagan (1994) claims that learners form communal practices in which learning is carried out through the mutual exchange of information. Within this framework, group members are accountable for the construction of their knowledge in addition to facilitating the learning process of other group members. This definition is perfectly in tune with Olsen and Kagan’s (1992) view, who contended that collaborative learning requires that learners exchange information while they are working together in order to enhance mutual learning. Additionally, the same scholars stated that collaborative learning is a group learning activity organized in such a way that learning is dependent on the socially structured exchange of information between learners in groups. Ormord (2011) supports that collaborative learning is an “approach to instruction in which students work with a small group of peers to achieve a common goal and help one another learn”.

It becomes obvious, therefore, that there are many definitions by various scholars with reference to collaborative learning, each one focusing on a number of different aspects of this teaching and learning approach. Undoubtedly, from the aforementioned definitions, it follows that the existing theoretical framework supports the adoption of collaborative learning in the context of the CONNECT approach since it provides substantial evidence shedding light on the plethora of academic, social, and pedagogical outcomes of applying collaborative learning systematically in the English language teaching classroom.

1.2 The conceptual framework of Collaborative Learning

Collaborative learning theory is rooted in Vygotsky (1978), who emphasized the importance of interaction between individuals in the construction of knowledge arguing that cognitive development is carried out via social interactions. He stated that the learning process will continue more efficiently as a result of interaction and collaboration among students who engage in pursuing tasks and activities in classroom context with peers who are more knowledgeable (Erbil, 2020).

Vygotsky’s social development theory highlighted the importance of communication and social interaction in the learning process. Consequently, it follows that when adopting the collaborative approach learners rely on one another to accomplish tasks and activities that they otherwise might not be able to complete individually. Cooperation, hence, proves to be a fruitful process resulting in changing the cognitive state of students.

In addition, Piaget stressed the prominence of the role of community and social interaction in all aspects of learning claiming that the aforementioned foster a positive learning environment. As a result, this leads to greater academic achievements and progress for all group members.

Furthermore, according to Johnson and Johnson (2009), the social interdependence theory brought forward by Lewin and Deutsch is the foundation of the collaborative learning method designating important insights for its implementation in the English Language classroom. Social interdependence theory posits that individuals are affected both by their own acts or those of other individuals (Johnson and Johnson, 2012). Therefore, the prominence of collaborative approach is stressed in order for the students to achieve common educational goals, a process which has to be not only a joint effort but also requires that every student holds responsibility for the process students are involved in for the successful completion of tasks and activities.

1.3. The difference between collaborative and cooperative learning

Let us now illuminate the difference between collaborative and cooperative learning as long as these two concepts are often used interchangeably and the distinction turns out to be of prime importance; drawing a distinction between cooperative and collaborative learning, Oxford (1997) states that cooperative learning is more "structured" and "prescriptive" while collaborative learning, with its different intellectual roots, connotes social constructivism.

According to Bruffee (1995), it is essential to differentiate between these terms since they have a somewhat different approach with reference to the teacher's authority in the classroom as well as the learners' interaction. Bruffee claims that in collaborative learning the students are self-governed whereas in cooperative learning the teacher plays an instructor-led role. In the former approach, the focus is on challenging each other's views while in cooperative the focus is that students contribute equally for the completion of the task. When collaborating there is space for dissent so that learners have the opportunity to express their own ideas stressing a strong difference of opinion on a particular subject. Cooperation, on the other hand, fosters consent especially about an official suggestion or plan or a popular belief.

As the same scholar put it, collaborative learning weakens students' accountability by shifting responsibility to the group as a whole, whereas cooperative learning puts the teacher as the central point of reference thus not allowing learners to further explore the dynamics of the group.

Panitz (1996) claims, however, that when undertaking to clarify the difference between collaboration and cooperation we run the risk of polarizing the educational community into a 'we' versus 'them' mentality. Essentially, there are so many benefits which accrue from both approaches that it would be unfair to lose any advantage gained from the student-student teacher interactions created by both methods. It should always be reminded that we must be careful to avoid a one-size-fits-all mentality when it comes to education paradigms and proceed to identifying the characteristics of collaborative learning, which are of crucial importance if we are to apply such a teaching and learning approach in the English language classroom.

1.4 The characteristics of Collaborative Learning

Johnson and Jonson (1999) argue that in order for an activity to be collaborative it has to be characterized by five basic elements, which are absolutely essential in order to ensure that the assigned activity will be productive. The tasks learners are required to complete, then, should not only attain the expected learning outcomes but create at the same time a collaborative environment in the classroom supporting learners in every step of implementation. These five characteristics are as follows:

Positive interdependence: it refers to the awareness that there is a sense of linking amongst member groups. "Positive interdependence is the perception that one is linked with other classmates in a way that one cannot succeed unless they do and that group mates' work benefits you and your work benefits them''. This inevitably implies that there are common shared goals which empower students to join their forces and work together effectively. "Interdependence" guarantees that all students take part in the group work and contribute. It is the teacher's responsibility to distribute the tasks in a way that every individual contribution is indispensable for the end result".

Individual accountability: each student holds the personal responsibility of implementing the activity successfully "when the performance of each individual student is assessed and the results are given back to the group and the individual" (Johnson & Johnson, 1999). This implies that each group member is assigned a task in order to work independently and afterwards receives feedback from the group. Unless each student contributes with his/her own forces and characteristics, is there a possibility to successfully complete the assigned task? "Each student's participation that is acknowledged can support students to keep contributing to their groups (Gregersen, 2017). Furthermore, Arta (2018) supports that the sense of "accountability makes students improve their sense of responsibility at their learning achievements as a part of collaborative group works".

Face-to-face promotive interaction: according to Johnson & Johnson (1992), "students promote each other's success by helping, assisting, supporting, encouraging, and praising each other's efforts to learn". When each student contributes to the success of the group, only then do they realize the imperative need for creating strong, positive connections. Exchanging and accepting different contrasting viewpoints on a topic facilitates learners to become tolerant and open-minded learning to respect each other's personality. Additionally, the aforementioned scholars argue that students should get involved in promoting each other's learning, explaining how to solve problems, discussing the nature of the concepts in question in addition to connecting present with past learning. Thus, the more face-to-face interaction amongst group members increases, the more the dynamics in the group increase, boosting the learners' social modeling and support (ibid).

Social skills: one of the fundamental principles of collaborative learning is to develop the communication skills among members of the group. Johnson & Johnson (1992) support that putting a socially unskilled student in a group instructing him/her to collaborate with other members does not necessarily mean that this process will be completed efficiently. Conflicts may arise because of the interaction either on the social or the cognitive domain. According to Eisenfeld (2018), social interaction results not only in mutual encouragement, cooperation and assistance but may also cause socio-cognitive conflict. Socio-cognitive conflict is an essential element and describes the situation when two students have contrasting viewpoints and approaches for the solution of a problem. At the end, this conflict "leads to progress, when a student takes into account his perspective while considering another's incompatible viewpoint" (Webb, 2009).

Group processing: Johnson and Jonson (1992) hold the opinion that "group processing exists when group members discuss how well they are achieving their goals and maintaining effective working relationships". Therefore, the learners are involved in the process of evaluating member actions and reactions so that they must make a decision on altering strategies in order to finally work together effectively when the need arises. Consequently, as soon as students face difficulties of any kind during the interaction process, they have to find an effective way to deal with the problem. As Eisenfeld (2018) put it, it is "the teachers' responsibility to supervise the learner's evaluation process and engage the students in some kind of quality management". Hence, group processing has to do with deciding who performed well and what actions should be continued or not. More specifically, group processing focuses on group members assessing individual contributions in order to make any adjustments necessary for succeeding (Johnson & Johnson, 1994).

1.5 The benefits of Collaborative Learning

In the existing literature, there are a number of benefits that are associated with the concept of collaborative learning. Unless we realize the advantages this teaching and learning approach offers, can we essentially adopt it to our learners' benefit. Applying the Collaborative Learning model, then, in the English Language Teaching seems to yield a number of benefits. According to the work of both Johnson and Panitz (1996), the benefits of collaborative learning can be categorized into major categories, i.e. social, psychological, and academic.

Before making any judgment on the merits and value of collaborative learning, it is worth mentioning that, particularly, in the 21st century collaboration is a philosophy of interaction and personal lifestyle where individuals are responsible for their actions, including learning and respecting the abilities and contributions of their peers. (Panitz, 1996). The underlying premise of collaborative learning is based upon consensus building through teamwork by group members, in contrast to competition in which individuals oppose other group members. "Shifting the emphasis from individual efforts to group work, from independence to community (Leonard, & Leonard, 2001) seems to be a state-of-the art trend. This shift of emphasis imposes a totally new approach to education as well allowing learners to benefit on various levels, academically, socially, psychologically.

To start with, Macaro (1997) argues that collaboration facilitates students to feel more confident as they learn through helping each other thus becoming autonomous. This, undoubtedly, implies that learners acquire independence having the power to make their own decisions, which results in developing life-long skills. He recommended that instructors apply collaborative instead of competitive goal structures as a way of developing interdependencies amongst students to enhance their self-confidence. Additionally, Cadiz-Gabejan (2021) claims that when learners are encouraged to collaborate with their classmates in activities applied in the English language classroom it would give them a main active role in the process of learning thus improving their self-confidence. He also continues claiming that there is a close irrefutable association between the extent of learners' participation in the classroom and their academic achievements. The latter is indeed proved in the existing research providing evidence that learners who participate actively in class usually attain higher achievement in their academics as compared to students who are inactive in class.

Smith and MacGregor (1992) contend that in collaborative learning "the development of interpersonal skills is as important as the learning itself. The development of social skills in group work is key to high quality group work. Many cooperative learning tasks are put to students with both academic objectives and social skills objectives". Intrinsic to this aspect is regular group processing that requires learners to reflect on the collaboration process aiming at "learning how to become more effective in group learning settings (Johnson, Johnson and Holubec, 1990). It becomes evident, therefore, that developing important social skills, improving communicative ability, and providing a positive model for lifelong learning (Kagan, 1994) provides the basis for collaborating in task completion and more specifically in the context of the CONNECT approach.

After all, according to Krupa-Kwiatkowski (1998), interaction incorporates individual engagement, participation in implementing activities that are believed to accelerate and initiate cognitive processes suitable to language learning. Gokhale, (1995) supports that collaborative learning is key for developing critical thinking skills, facilitating students to retain more knowledge and information when working in groups. The latter will inevitably boost students' motivation to learn when they successfully complete an assigned task and learning will end up being an ongoing and fruitful process in the English Language classroom.

2. The teacher's and the student's role in Collaborative Learning

Berry (1991) claims that "collaborative experiences require both teacher and students to risk a departure from the traditional teacher/pupil behavior to venture into a different kind of academic partnership". Applying collaborative learning in everyday classroom practices signifies a shift of emphasis from a teacher-centered to learner-centered approach, where the roles of students and learners change. On the one hand, learners are challenged both on an emotional and social level having to justify and support their own perspectives as a group member whereas on the other the teacher has to orchestrate the learning process efficiently facilitating students to reach the predefined common learning goals. Learners are motivated to interact with their classmates in order to accomplish tasks as part of the teaching and learning process.

Involving learners in interaction activities requires that classroom roles are modified. Evangeline (2016) supports that "both teachers and students take on more complex roles and responsibilities. The classroom is no longer a solo teacher and individual students - it becomes more an interdependent community". As a result, this possibly might create tensions and problems in the relationships amongst students and teachers, which may after all exist in all learning communities. The same scholar argues that "this degree of involvement often questions and reshapes assumed power relationships between teachers and students, (and between students and students), a process that at first can be confusing and disorienting". This is, undoubtedly, in line with Laal & Ghodsi (2012) argument that "there is a sharing of authority and acceptance of responsibility among group members for the groups' actions".

The teacher's role during collaborative learning requires the stimulation of constructive, productive and beneficial interactions between learners. In order to achieve this, it is essential for the teacher to organize and support student interactions in the context of academic tasks and activities preparing at the same time the learners for collaborative work with their classmates. Accordingly, it follows that the interaction keeps taking place both between students as well as the students with their teacher thus all of them forming a network of collaboration.

In fact, the way and the extent to which teachers orchestrate and take more or less control of these instances determine whether these opportunities can be turned into real learning for the students. As Smith & MacGregor (1993) eloquently put it, after all, “teachers who use collaborative learning approaches tend to think of themselves less as expert transmitters of knowledge to students, and more as expert designers of intellectual experiences for students - as coaches or midwives of a more emergent learning process”.

Undoubtedly, teachers can further provide opportunities for stimulating learning thus playing a fundamental role in supporting interaction amongst students. Emmer & Gerwels (2005) clarify the view that the metaphor of the teacher as a facilitator of collaboration under no circumstances should be falsely taken to mean that he/she plays a passive role. This is by no means the case as long as it is always a great challenge for the teacher to remain a central figure in supporting collaborative learning. This way, exploiting the moments in which opportunities for students to learn arise, the learning process will take place. Learning, consequently, will be considered as a permanent change brought about to students since teachers create a proper learning environment through a plethora of techniques, in order to develop specific skills, change attitudes, or understand concepts always according to the curricula (Sequeira, 2012).

The most effective strategies for doing so are giving feedback, prompting and questioning students, and transferring control over the learning process to students (Leeuwen & Janssen, 2019). Therefore, it can be concluded that instant feedback as well as both individual and group accountability contributes to the success of the lesson and the achievement of the predefined lesson aims and objectives. It follows, then, that teacher monitoring of the process can be associated with attaining the expected learning outcomes. Nonetheless, it is worth mentioning that the material prepared by the teacher, which is delivered to each group member for implementation, is of crucial importance. In order to ensure student learning, collaborative activities should be stimulating and challenging thus arousing the students’ interest in group work and encouraging their progress.

No doubt, collaborative learning poses multiple challenges for students. At the same time, they are expected to complete an assignment making sure that the group’s efforts are orchestrated efficiently, controlling their own learning process and being accountable for ensuring the learning process of their classmates. Inevitably, it is the teachers’ task to coordinate these efforts giving the right instructions to each group member as well as clarifying that there is a shared educational goal to be achieved. This requires that teachers practice these vital competences and skills with the learners as long as teachers no way should they take for granted that students have the ability to manage the aforementioned responsibilities.

Unquestionably, the teacher's role in orchestrating collaborative learning is multidimensional since it requires teachers to structure the group-work task effectively in advance, it includes multiple dimensions in fostering beneficial group dialogue, including preparing students for collaborative work, forming groups, and influencing student interaction through teachers' discourse with small groups and with the class. The latter constitutes a real challenge for every teacher.

3. Collaborative Learning and its relation to the CONNECT approach

The contribution of collaborative learning could not be neglected in the implementation of the CONNECT approach. The fundamental principles of collaborative learning are taken into account in the proposals formulated within the framework of the CONNECT Erasmus programme since students are assigned collaborative activities in the classroom in Phase B of the digital scenarios. As designed, students are asked to work in groups carrying out activities based on content material relevant to all three subjects, namely Mathematics, Physics and Foreign Language Curricula.

In this respect, the Erasmus+ CONNECT project fosters implementing various collaborative tasks and activities. In Phase B of the scenarios during class time in the flipped classroom, any active learning method can be used while implementing in-class activities. Khanova et al. (2015) hold the significant opinion that the flipped classroom model relies, in part, on a student's capacity for self-regulation of pre-class learning and on the teacher's ability to design in-class interactive activities that facilitate higher-order thinking such as problem solving. The flipped classroom approach is considered having many advantages for numerous reasons as long as it provides students with the ability to have control of ownership of the learning process facilitating them to develop critical thinking skills simultaneously equipping them with skills to address the 21st century challenges, as mentioned earlier. In the classroom, learning activities appropriate for higher-level cognitive achievements must be carried out in order to promote learning. Under these circumstances, the collaborative learning approach is considered one of the most suitable teaching approaches which fosters a flipped classroom environment (Bishop & Verleger, 2013 in Erbil, 2020). This will ultimately have a positive impact on students' academic success and further academic achievements.

To put it in a nutshell, in the classroom context, the Flipped classroom and the collaborative learning approach are teaching methods which can be aligned with up-to-date education needs. Hence, it can be suggested that it is effective and beneficial for learners when teachers apply collaborative learning along with the Flipped classroom, since the theoretical roots of both are based on active learning.

4. Conclusion

Collaborative learning is widely used in education and it is one of the realistic and pragmatic teaching approaches where the learners work in teams or groups in order to solve an issue, generate an artifact or understand a notion or concept. In collaborative learning, learners involve one another in order to get the correct information, assess their notions and scrutinize or monitor their work together. Emphasis is put on forming small teams using a variety of learning activities in order to both improve understanding of a subject as well as acquire social awareness.

Thus, it is imperative that collaborative learning is adopted as a teaching method and approach. The existing literature provides the educational community with useful and substantial insights into incorporating the benefits of applying the Flipped Classroom method in combination with collaborative learning.

Vygotsky's (1978) social learning theory can definitely support the advantages of collaborative learning, i.e. motivation, social cohesion, progress, and cognitive development. In this model, individuals' competitive behavior is discouraged in favor of collaborative group-centered learning. As a result, attaining both academic and social goals is facilitated (Gillies & Boyle,

2010) promoting learning, which becomes interactive, effective, stimulating and above all resulting in acquiring knowledge applicable to every-day situations.

A large body of research sheds light on the fact that students benefit both academically and socially when they are offered opportunities to interact with peers to accomplish shared goals (Johnson, et al, 2000). Collaborative learning does not exclude other forms of teaching. In fact, research has shown that combining other forms of teaching with collaborative learning leads to long lasting learning outcomes. The latter is, after all, the aim and objective of educational systems worldwide.

The existing research concludes that teachers can play a significant role particularly during the phase of interaction while students collaborate. In this phase, teachers can act as a point of reference or play a role model for students as long as they can demonstrate themselves how to interact with group members. Furthermore, teachers can stimulate and inspire students to explain their own ideas to group members, clarifying the way they reached such a conclusion by asking appropriate follow-up questions. As a result, collaboration will be more effective and fruitful since it provides the opportunity to deepen the group discussion, hence, developing a collaboration environment (Webb et al. 2009). Students need to be guided how to interact and specific attention needs to be paid to how to orchestrate learners' working processes so that they successfully accomplish creative collaboration tasks and activities.

Collaboration is an interdependent process while learners learn to depend on each other's contribution for successfully completing a task or an activity the teacher has assigned to them. It involves not only the sharing of ideas as a group but generating entirely new ideas together. Hence, it becomes obvious that fundamental assumptions related to the teaching approach of collaborative learning are principles such as communication, interaction, and students' individual accountability. Not only do students work together in this context, but they also enrich and complement each other's learning in a way that enhances social awareness, communication skills, and language learning competence. A most welcome approach in the implementation of the CONNECT approach.

5. References

Arta, B. (2018). Multiple Studies: *The Influence of Collaborative Learning Approach on Indonesian Secondary High School Students' English-Speaking Skill*. English Language Teaching Educational Journal (ELTEJ), vol. 1 (3), pp. 149-160.

https://files.eric.ed.gov/fulltext/EJ1288197.pdf

Berry, L. J., (1991). *Collaborative Learning - A program for improving the retention of minority students.*

https://files.eric.ed.gov/fulltext/ED384323.pdf

Bruffee, K. A., (2010). *Sharing Our Toys: Cooperative Learning Versus Collaborative Learning*, vol. 27 (1), pp. 12-18.

https://doi.org/10.1080/00091383.1995.9937722

Cadiz-Gabejan, A. M. (2021). *Enhancing Students' Confidence in an English Language Classroom, International Journal of English Language Studies*, vol. 3 (5), pp. 16-25.

https://www.researchgate.net/publication/351959897_Enhancing_Students'_Confidence_in_an_English_Language_Classroom

Cohen, E. (1994). *Restructuring the classroom: Conditions for productive small groups*. Review of Educational Research, vol. 64, pp. 1-35.

https://files.eric.ed.gov/fulltext/ED363952.pdf

Eisenfeld, S. (2018). The teacher's role in cooperative learning in inclusive classrooms, Munich, GRIN Verlag.

https://www.grin.com/document/459666

Emmer, E.T., Gerwels, M.C. (2002). *Cooperative learning in elementary classrooms: Teaching practices and lesson characteristics.* The Elementary School Journal, vol. 103 (1), pp. 75-91.

https://eric.ed.gov/?id=EJ658012

Erbil, D. G. (2020). *A Review of Flipped Classroom and Cooperative Learning Method within the Context of Vygotsky Theory*. https://doi.org/10.3389/fpsyg.2020.01157

Evangeline, J., (2016). *Empowering Students Success through Collaborative Learning*,

International Journal of Emerging Trends in Science and Technology, vol. 3 (11), pp. 4760-4763. https://journals.indexcopernicus.com/api/file/viewByFileId/182641.pdf

Gillies, R. M., & Boyle, M. (2010). *Teachers' reflections on cooperative learning: Issues in implementation.* Teaching and Teacher Education, 26(4), pp. 933-940.

https://www.academia.edu/30390928/Teachers_reflections_on_cooperative_learning_Issues_of_implementation

Gokhale, A. A. (1995). *Collaborative Learning Enhances Critical Thinking*. Journal of Technology Education vol. 7 (1), pp. 22-30.

https://scholar.lib.vt.edu/ejournals/JTE/v7n1/pdf/gokhale.pdf

Gregersen, T. (2017). *Improving the interaction of communicatively anxious students using cooperative learning*. Lenguas Modernas, vol. 26-27, pp. 119-133. https://revistas.uchile.cl/index.php/LM/article/viewFile/45488/47555

Johnson, D. W., & Johnson, R. T., (1999). *Making cooperative learning work*. Theory into Practice, vol. 38 (2), pp. 67–73.

https://www.researchgate.net/publication/243775553_Making_cooperative_learning_work

Johnson, D. W., & Johnson, R. T. (2012). Social interdependence theory. In D. J. Christie (Ed.), Encyclopedia of Peace Psychology. Hoboken, NJ: Wiley-Blackwell.

https://www.researchgate.net/publication/260596760

Johnson, D. W., Johnson, R. T., & Holubec, E. J. (1986). Circles of learning: cooperation in the classroom. Edina, Minn., Interaction Book Co.

Johnson, D. W., Johnson, R. T., & Stanne, M. B. (2000). *Cooperative learning methods: A metaanalysis.*

https://www.researchgate.net/publication/220040324_Cooperative_learning_methods_A_meta-analysis

Kagan, S. (1994). Cooperative Learning. San Clemente, CA: Kagan Publishing.

Khanova, J., Roth, M. T., Rodgers, J. E., McLaughlin, J. E., (2015). *Student experiences across multiple flipped courses in a single curriculum.* Medical Education, vol. 49, pp. 1038–1048. doi: 10.1111/medu.12807

Krupa-Kwiatkowski, M., (1998). *"You Shouldn't Have Brought Me Here!": Interaction Strategies in the Silent Period of an Inner-Directed Second Language Learner*. Research on Language and Social Interaction, vol. 31 (2), pp. 133-175.

https://www.researchgate.net/scientific-contributions/Magda-Krupa-Kwiatkowski-34883279

Laal, M., & Ghodsi, S. M., (2012). *Benefits of collaborative learning*. Social and Behavioral Sciences, vol. 31, pp. 486 – 490.

https://www.researchgate.net/profile/Marjan-Laal/publication/224766541

Laal, M. & Laal, M., (2001). *Collaborative learning: what is it?* Social and Behavioral Sciences. pp. 491-495.

https://www.researchgate.net/publication/224766528_Collaborative_learning_What_is_it

Leonard, P. E. & Leonard, L. J., (2001). The collaborative prescription: Remedy or reverie? International Journal of Leadership in Education, vol. 4 (4), pp. 383-399.

researchgate.net/publication/240528926_The_collaborative_prescription_Remedy_or_reverie

Le, H., Janssen, J. and Wubbels, T. (2016). *Collaborative learning practices: teacher and student perceived obstacles to effective student collaboration.* Cambridge Journal of Education. vol. 48 (1), pp. 103-122.

https://www.tandfonline.com/doi/full/10.1080/0305764X.2016.1259389

Leeuwen, A., & Janssen, J., (2019). *A systematic review of teacher guidance during collaborative learning in primary and secondary education*, Educational Research Review, vol. 27, pp. 71-89. https://doi.org/10.1016/j.edurev.2019.02.001

Macaro, E. (1997). Target language, collaborative learning, and autonomy. Bristol: Multilingual Matters Ltd.

Olsen, R. E. W. B., & Kagan, S. (1992). About cooperative learning. In C. Kessler (Ed.), *Cooperative language learning: A teacher's resource book* (pp. 1-30). Englewood Cliffs, NJ: Prentice Hall

Ormrod, J. E. (2011). Educational psychology: Developing learners (6th ed.). Upper Saddle River, NJ: Merrill Prentice Hall.

Oxford, R. (1997). Cooperative learning, collaborative learning, and interaction: Three communicative strands in the language classrooms. *The Modem Language Journal*, vol. 8l, pp. 443- 456.

Panitz (1996). Collaborative versus Cooperative Learning: A Comparison of the Two Concepts Which Will Help Us Understand the Underlying Nature of Interactive Learning.

https://files.eric.ed.gov/fulltext/ED448443.pdf

Rochelle, J., & Teasley, S. D. (1995). The construction of shared knowledge in collaborative problem solving. In C. O'Malley (Ed.), Computer supported collaborative learning. pp. 69-97, Berlin: Springer.

Rowse, S. J., and Emerson, L.M. (2016). The role of collaboration in the cognitive development of young children: a systematic review. Child: Care, Health and Development, vol. 42 (3). pp. 313-324. https://doi.org/10.1111/cch.12330

Sequeira, A. H., (2012). *Introduction to Concepts of Teaching and Learning. National Institute of Technology Karnataka, Surathkal*, India., social sciences education e-journal. https://ssrn.com/abstract=2150166 or http://dx.doi.org/10.2139/ssrn.2150166

Slavin, R. E. (1980). Cooperative Learning. Review of Educational Research, vol. 50 (2), pp. 315–342. https://doi.org/10.3102/003465430500023

Stein, M., Edwards, T., Norma, J., Roberts, S., Safrs, J., Alec, R., (1994). A Constructivist Vision for Teaching, Learning, and Staff Development. Wayne State University College of Education and Juanita Clay Chambers. https://files.eric.ed.gov/fulltext/ED383557.pdf

Smith, B. L. & Jean T. MacGregor J. T., (1993). What is Collaborative Learning?

https://www.researchgate.net/publication/242282475_What_is_Collaborative_Learning

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.

Webb, N. M., (2009). The teacher's role in promoting collaborative dialogue in the classroom.

https://doi.org/10.1348/000709908X380772

Webb, N.M., Franke, M.L. Tondra, D., Chan, A.G., Freund, D., Shein, P. (2009). *Explain to your partner: Teachers' instructional practices and students' dialogue in small groups.* Cambridge Journal of Education, vol. 39 (1) pp. 49-70. https://doi.org/10.1080/03057640802701986

Review of Mathematics Scenarios

Yiorgos Mavrommatis [1], gmaurommatis@gmail.com

Eirini Kouletsi [2], kouleir@gmail.com

[1] *Researcher at NKUA, Athens*

[2] *Mathematics Teacher at the Varvakio Model Junior High School,*

Abstract

This article aims to present the review of mathematical educational scenarios developed in the context of the "CONNECT" programme. Nine scenarios were evaluated in relation to the didactic approach of the flipped classroom model, the pedagogical and educational adequacy, and their contribution in terms of added value in the process of teaching and learning basic mathematical concepts of the Middle School. Overall, the scenarios were characterized as consistent with the international research literature in relation to most of the principles of the flipped classroom and blended learning, contributing significantly to teaching reform and improving the learning process. At the same time, they implement teaching practices that support active learning, inclusion, the use of digital tools, inquiry and collaborative learning and argumentation. On this basis, specific additions and extensions are suggested to optimize their implementation by teachers.

Keywords: active learning, inclusion, digital tools

1. Introduction

1.1 Teaching and learning mathematics today

It is a commonplace in mathematics education, the need to enrich teaching with new practices that will focus on the needs of students and provide them with more and better learning opportunities. The frontal instruction and lecture models developed in the past are reaching their limits in today's age of technology and diversity failing to meet the needs of students nowadays. Thus, it is necessary to develop teaching and learning methods that will include the technological, social, and wider changes that characterize our time making use of the research findings in the field of mathematics education. In this direction, research in the field has developed various practices and perspectives aimed at active learning, inquiry, inclusion, formative assessment, and conceptual understanding, utilizing digital tools, enhancing the development of argumentation, critical thinking and collaborative learning.

1.2 Research in the field of teaching and learning mathematics

Mathematics plays an important role in the further development of individuals and society (Hoyles, Morgan, & Woodhouse, 1999). Student achievement and learning experience in mathematics is critical in STEM (science, technology, engineering, and mathematics) education (Dove and Dove, 2015; Ogden, 2015; Petrillo, 2016; Van Sickle, 2016). However, Phillips and Phillips (2016) observed that students often experience high levels of math anxiety. As Petrillo (2016) and Ogden (2015) cautioned, students' negative experiences in learning mathematics could discourage them from choosing careers in STEM fields. Some mathematics educators (Ford, 2015; Ichinose and Clinkenbeard, 2016) have suggested that the flipped classroom approach has the potential to improve mathematics teaching and learning. In a typical flipped classroom, teachers provide lectures before class meetings using instructional videos or other multimedia instructional materials (Bishop and Verleger, 2013; Lo and Hew, 2017). Thus, classroom time is freed from teacher-centered instruction and can be used for student-centered learning activities, such as collaborative problem solving with teacher guidance (Bishop and Verleger, 2013; Giannakos et al., 2014; O'Flaherty and Phillips, 2015).

2. Approach

2.1 General framework for project evaluation

The evaluation of the following scenarios was based on the principles of the flipped classroom as recorded in the international research literature. The projects were also evaluated in terms of the completeness and clarity of their presentation, the pedagogical framework, the teaching objectives they set, the teaching practices they apply, the learning impact they achieve as well as the activities and materials they use to achieve the objectives.

2.2 Flipped classroom principles

The flipped classroom approach is based on nine basic principles as described by LO, Chung Kwan et al., 2017. The first two principles concern the transition to the flipped classroom model, the next three concern the Out-of-class learning design, while the last five concern the In-class learning design. The first principle is managing the transition to the flipped classroom for students. In other words, the preparation of the student community to understand how the model works as well as the ways of their involvement in it. The second principle is to manage the transition for teachers to the flipped classroom model so that they can develop scenarios and make meaningful use of the possibilities it offers. The third principle concerns the development of introductory material and the provision of online support with video lectures. The fourth principle is about enabling effective multimedia learning using short instructor-generated videos. The fifth principle is about using online exercises with grades to motivate students' class preparation. Assessing their practice through a rating scale provides them with useful feedback and self-regulating. The sixth principle concerns the modification of in-class teaching plans based on students' out-of-class learning performance. The seventh principle is about activating students' pre-class learning by using a structured formative assessment such as a quiz at the start of face-to-face lessons. The eighth principle is the solving of various tasks and real-world problems by the students in the classroom. A ninth principle concerns meeting the needs of students through instructor feedback and differentiated instruction. Finally, the tenth principle is about facilitating peer-assisted learning through small-group learning activities.

3. Results

3.1 Positive reviews and benefits

The nine scenarios that were evaluated, although there are significant qualitative differences among them in relation to the adopted principles of the flipped classroom as well as the materials they use and the content of their activities, essentially each one contributes to the upgrading of the teaching and learning process. Most utilize some of the principles of the flipped classroom but retain many of the learning benefits of the model.

The emphasis on the development of soft skills such as collaboration between students, critical and creative thinking and the use of digital tools (digital skills), are features that support some of the scenarios, while some certain improvements can be made. Some scenarios, in addition, emphasize the importance of problem solving, thus supporting inquiry learning.

In some of them, the teaching objectives set in relation to the concepts they negotiate, consistently and fully support the specifications of the curricula as they are defined in each case. Also, the timetables as well as the time required for their implementation in the classroom are in alignment with the key requirements of the curriculum.

In terms of teaching practices, the scenarios have broadness and variety in relation to the materials they use, the methods of student involvement and motivation in each phase of teaching as well as the assessment tools applied for teacher and student feedback. Thus, as positive aspects are identified the use of digital tools (Geogebra, sketchpad) and hands-on materials, the emphasis on interaction at individual level (interactive videos, interactive applications) and collective (jigsaw method), the support of an environment that contributes to developing argumentation among students, the collaboration in groups and the presentation of the results to the whole class, the worksheets as guide in the learning process and the evaluation sheets to reflect on the learning outcome. It should be noted that the incorporation of the above practices differs among scenarios, so some support them entirely while others make use of some of them only.

In relation to the activities they use, they present some differences. It is positive that in all the scenarios procedural learning is sufficiently supported through various exercises of escalating difficulty. In this way, students' proficiency is achieved with reference to the ability to solve basic but also more complex exercises always in relation to the concepts they are studying. Additionally, some projects emphasize multiple representations, especially in cases involving algebraic concepts, to make them intuitively accessible to students. In this direction, the use of digital tools of dynamic representation that aim at visualization on the one hand and at investigation and experimentation on the other is evaluated positively. The use of non-examples and counterexamples applied to some of the activities encourages inquiry learning, supporting conceptual understanding of mathematical notions. In the same direction, activities that seek creative and critical thinking through the evaluation of the truth or falsity of sentences that contain common misconceptions and mistakes of students are evaluated as well positively. Hands-on materials that utilize some scenarios are another aid to the development of students' creative thinking and conceptual understanding through the intuitive negotiation they provide. Finally, activities that use realistic problems through which students study concepts and recognize their importance in the real world are evaluated positively.

3.2 Weaknesses and deficiencies

The nine scenarios evaluated show many positive points as mentioned in the previous section, but at the same time there are features that show inconsistencies, weaknesses and deficiencies.

In relation to the characteristics and principles of the flipped classroom, some weaknesses are identified. According to the literature, it is important that the videos created in the first phase of asynchronous teaching are a product of the teacher. Selecting and creating appropriate videos is of particular importance to achieve the best possible understanding of the concept by the student. As it has been observed in the research, when the students are unable to understand the cognitive content presented to them through the various materials (videos, texts, etc.), the consequence is that the teacher presents the concepts again in the classroom, limiting the benefits of the model. Thus, it is more appropriate to create videos and materials from the teacher himself/herself who knows the needs and capabilities of his students. The material presented to the students should focus on introductory issues of the concepts such as terminology, definitions, symbols and basic applications of the exercises to limit the potential questions that may arise. Issues involving proofs, complex exercises and inquiry problems can be exploited during the phase of teaching in the classroom where there is more interaction. Also, it is important that the videos are of short duration providing at the same time the capability of self-assessment of the student's understanding in an interactive way. Finally, the students' ability to understand and consolidate the topics increases when learning is supported by digital tools for dynamic and interactive negotiation of concepts. In this direction, deficiencies concerning issues of interaction with the available materials (texts, videos, etc.) limit the benefits that flipped classroom model can provide.

The teaching objectives presented in some scenarios in relation to the activities they use show some inconsistencies and deficiencies. The inconsistencies concern either cases where teaching objectives stated are not achieved through the corresponding activities, or activities that seek to achieve specific learning outcomes that are not mentioned in the scenario. Deficiencies are also observed in relation to teaching objectives and corresponding activities, which should seek to develop multiple representations of the concepts negotiated by students, with the aim of enhancing their understanding. In other words, the use of dynamic representation tools so that students can understand in a supervisory way the algebraic relationships they manage constitutes a real necessity. Some objectives need to be more clearly stated in order to accurately represent the learning outcomes in focus. In addition, some objectives related to the development of soft skills such as inquiry, critical thinking, creativity and digital skills are not sufficiently supported through the activities and the underlying teaching practices.

According to the above, some activities need improvements in the direction that will be harmonized with the teaching objectives set as well as the teaching practices applied. In particular, there are deficiencies in activities that intend to utilize supervisory tools (manipulative tools, digital tools) to enhance investigation, critical thinking and creativity. Also, in some scenarios the sequence of activities does not adequately support a scaffolding learning process towards generalization whereas in some cases the flow of activities does not serve any visible goal. Furthermore, there are activities that require knowledge which is not explicitly mentioned in the description of the scenario and is not presented or studied in any way. An additional observation regarding the activities and teaching practices is the selection of problems that should focus on critical thinking issues rather than simple application of rules and procedures. That kind of problems are open-ended, in which the student must evaluate conjecture reasoning as true or false with justification or inquiry problems where through observation he/she constructs rules and generalizes them symbolically as well as problems of counterexamples or non-examples.

Finally, with reference to the third phase of teaching, where the evaluation of the knowledge acquired by the students is carried out, it is important that the activities developed aim at consolidating learning. That is, the objectives and the actions that support consolidation, to provide the required feedback to both the student and the teacher about the learning process in the two previous phases. In some scenarios during the third phase, objectives, activities and materials do not serve the evaluation but they constitute study material for topics that should have preceded in other phases. Specifically, the remark concerns processes and concepts that were not sufficiently discussed in the classroom and appear in the activities of the third phase, digital materials (videos) that should have been studied during the first phase of teaching where the student is introduced to the concept and misplaced goals in relation to students' understandings of negotiated concepts, which should be completed during the classroom instruction phase.

4. Discussion

Based on the above observations, we list indicatively in a general context some focal interventions and changes that could improve the worthy effort of the nine scenarios. With respect to the flipped classroom features, improvements can be made in the direction that scenarios will be more consistent to the principles as documented in the literature research. Short and interactive videos and materials from the class teacher at phase A, which will aim at the introductory involvement of the students with the basic principles of the mathematical concepts, while at the same time they will provide the capability of self-evaluation of the student. Also in this phase, other digital tools (e.g. Geogebra) could be used to increase the interactivity with the material. In relation to the teaching objectives, it is proposed to align them with the activities they use and the prerequisite knowledge they demand. Improvements can also be made in clarifying objectives and enriching teaching practices that will better support the development of the soft skills listed. In relation to the activities, some of the suggestions for improvement are the enrichment with more digital and observational tools during the classroom teaching phase, the creation of open-ended problems for investigation that will further promote critical thinking and conceptual learning as well as the sequence of activities that will aim uniformly at some final cognitive goal. Finally, improvements can be made in relation to the phase of learning assessment (Phase C), where the activities and objectives will adequately support the feedback of both the student and the teacher avoiding the negotiation of subjects that correspond to previous phases of learning and teaching.

5. Conclusion

From the observations and comments reported, the significant contribution of the nine scenarios using elements of the flipped classroom and blended learning model is established. At the same time, are recognized the utilization and integration of materials (digital tools, worksheets, interactive media, hands-on materials) and teaching practices (active learning, inquiry learning, development of communication and cooperation, use of realistic problems, self-regulation) that support the educational and learning objectives (conceptual understanding and procedural competence, problem solving ability, development of critical thinking, creativity, digital skills) that set. Based on the evaluations of the scenarios combined with the existing literature, specific interventions and improvements were proposed so that the scenarios fulfill their objectives in the best possible way. After all, the effort to reform and improve the teacher's work is a continuous process without end. The aim of the remarks and suggestions is to increase their functionality in the context of teaching and learning and not to indicate any correctness. Through the cooperation of all the agencies involved and their work for the creation, evaluation and implementation of the nine scenarios, the added value in the learning process is established utilizing modern learning methods and the available digital tools. Finally, teaching with the flipped classroom model is a practice not familiar to the average teacher, at least for the Greek reality, and based on the aforementioned learning benefits, we believe that further training of teachers in order to adopt and implement it the right way would work positively.

6. References

Bishop, J., & Verleger, M. A. (2013, June). The flipped classroom: A survey of the research. In *2013 ASEE Annual Conference & Exposition* (pp. 23-1200).

Dove, A., & Dove, E. (2015). Examining the Influence of a Flipped Mathematics Course on Preservice Elementary Teachers' Mathematics Anxiety and Achievement. *Electronic Journal of Mathematics & Technology*, *9*(2).

Ford, P. (2015). Flipping a math content course for pre-service elementary school teachers. *Primus*, *25*(4), 369-380.

Giannakos, M. N., Krogstie, J., & Chrisochoides, N. (2014, November). Reviewing the flipped classroom research: reflections for computer science education. In *Proceedings of the computer science education research conference* (pp. 23-29).

Hoyles, C., Morgan, C., & Woodhouse, G. (Eds.). (1999). *Rethinking the mathematics curriculum* (Vol. 10). Routledge.

Ichinose, C., & Clinkenbeard, J. (2016). Flipping college algebra: Effects on student engagement and achievement. *Learning Assistance Review*, *21*(1), 115-129.

Lo, C. K., Hew, K. F., & Chen, G. (2017). Toward a set of design principles for mathematics flipped classrooms: A synthesis of research in mathematics education. *Educational Research Review*, *22*, 50-73.

Ogden, L. (2015). Student perceptions of the flipped classroom in college algebra. *Primus*, *25*(9-10), 782-791.

Petrillo, J. (2016). On flipping first-semester calculus: A case study. *International Journal of Mathematical Education in Science and Technology*, *47*(4), 573-582.

Phillips, L., & Phillips, M. (2016). Improved Student Outcomes in a Flipped Statistics Course. *Administrative Issues Journal: Connecting Education, Practice, and Research*, *6*(1), 88-98.

Van Sickle, J. R. (2016). Discrepancies between student perception and achievement of learning outcomes in a flipped classroom. *Journal of the Scholarship of Teaching and Learning*, *16*(2), 29-38.

Assessing the developed Physics educational scenarios

Konstantina Chrysanthakopoulou (1) , chrysandina@gmail.com

Nikolaos Papadimitropoulos (2) , npapadimitropoulos@gmail.com

(1) Science Teacher, 8th Junior High School of Chalandriou

(2) Science Teacher, Dr., Principal of 8th Junior High School of Korydallos

Abstract

The careful study of the 9 produced educational scenarios using the flipped classroom model for Physics course yielded quite interesting results. The main thing is that the flipped class model is not fully understood by some of the scenarios' writers. The most important is that asynchronous phases A and C have been translated, incorrectly by the writers, as a lesson through an online platform with the teacher's presence, while phase B is a lesson in the classroom. Also, equally important is that in the Italian and Cypriot educational scenarios the evaluation method does not coincide with modern pedagogical considerations.

Introduction

Keywords: flipped classroom, clear objectives, teaching phases, student work, student age, evaluation-sheets, metacognition, time adequacy, activities

The Greek scenarios follow the steps of the flipped classroom model, are clearly written and help the teacher to implement them. They have clear objectives, compatible with the aims of the lesson course and a series of targeted activities to achieve them. The evaluation sheets check the achievement of all predetermined objectives and are made according to modern pedagogical considerations. If implemented, they will pay off in the educational process.

The Italian scenarios are clearly written and have clearly stated objectives. However, there are no evaluation sheets to check whether the objectives have been achieved. They contain quite interesting activities, some of which, however, are more demanding for the age of the students they refer to, and some go beyond the time limit that has been set. The VOLCANOES scenario follows the flipped classroom model, while the other two do not. With some small changes they will pay off in the learning process if implemented.

The Cypriot scenarios are vague, without well-defined objectives, without correct terminology of objectives and do not all of them follow the flipped classroom model. They are applicable educational scenarios, after some improvements. They contain too many activities and time is not enough. There is no assessment of teaching, nor the achievement of metacognition. There are individual activities and worksheets that are very apt which, with an improved scenario, would add to the learning process.

Evaluation of educational scenarios from different countries

The evaluation of educational scenarios from different countries with different educational systems and with different educational curricula is an extremely difficult and laborious process, especially when it comes to educational scenarios based on a new teaching method that has not been implemented in the classroom in any of the countries participating in the CONNECT program.

The flipped classroom model

The flipped classroom model has special characteristics that are often misinterpreted by the authors of educational scenarios, resulting in the confusion of the different phases of teaching and the role of the teacher. They consider the asynchronous phase to be the course through an online teaching platform and the synchronous phase to be the course in the classroom. The result is that the teacher is present almost in all phases and directs the students. This is how we end up again in the teacher-centered teaching model.

Use and abuse of digital tools

In the context of the flipped classroom, digital educational tools are used for the needs of the course and to make the scenario modern, friendlier and more interesting for the student. But some of the authors of the specific educational scenarios fall into the trap of abusing digital tools, which reduces the educational value of the scenario.

The evaluation of the teaching in the scenarios

The evaluation of the teaching and more generally of the learning process described by the specific educational scenarios should follow modern pedagogical considerations. For example there must be, in addition to the evaluation of the achievement of the teaching objectives, an evaluation of whether the scenario leads to the development of skills that are at the higher levels of Bloom's taxonomy of objectives. Thus the self-assessment should check whether these skills have been acquired and not whether the lesson has been learned. Something like this is missing from some scenarios.

Approach

2.1 Definition of evaluation criteria

The evaluation was carried out according to criteria developed by school counselors of Natural Sciences and active teachers, based on the principles of the flipped classroom model and modern pedagogical considerations for the writing of educational scenarios, the definition of objectives and the way to evaluate students and teaching.

2.2 Scenario evaluation criteria

During the evaluation of the scenarios it was checked whether the scenarios correctly follow the steps-phases of the flipped classroom and whether they are clearly written. If the objectives are clearly and correctly defined, so that it is understandable to the teacher, who wants to implement them, what he must do and in what order, what the student must do and what he must achieve through each activity of the scenario. It was checked, if there is relevance of the objectives to the teaching subject - unit according to the Curricula, if the scenario and the activities coincide with the proposed teaching of the course defined by the Curriculum, if it contributes to active learning and collaboration teacher-student and students among themselves, without requiring learning materials and learning resources beyond those provided by a public school. Whether the duration of the educational hours is sufficient to complete the scenario and whether the activities it contains are suitable for the age group for which they are written. It was also checked whether the evaluation of teaching is done in accordance with modern pedagogical considerations and whether it checks that all the goals that have been set have been achieved and to what extent this has been done. If, finally, the scenario leads, in addition to the acquisition of declarative knowledge, to the development of skills that are at the higher levels of Bloom's target taxonomy.

Results

Briefly, we list below the negative points-weaknesses of each scenario that we identified during the study of the scenarios.

GREEK SCENARIOS

REFRACTION

The answer to the question why the arrow is reversed is not obvious to the students within the activities. Some activities with materials that are not usually found in a school laboratory are more demanding. The definition-concept of speed does not exist in the prerequisite knowledge.

ELECTRIC DIPOLES-OHM'S LAW:

The 4 phases that have been entered instead of three and it confuses the teacher. It also does not evaluate diagram drawing.

STUDY OF ELECTRICAL CIRCUITS: CONNECTING RESISTORS

Worksheet 2 takes more than 40' to make both types of connections.

CYPRUS SCENARIOS

MEASUREMENTS- FUNDAMENTAL QUANTITIES OF MECHANICS

It has ambiguities. Objectives are wrongly worded and soft skills are wrong. There are no goal achievement evaluation sheets and self-assessment sheets. Only the acquisition of declarative knowledge is tested. In the scenario, a large part is devoted to instructions for connecting and using a specific digital platform.

DERIVATIVES OF PHYSICAL QUANTITIES OF MECHANICS:

It has ambiguities. Objectives are wrongly worded and soft skills are wrong. There are no goal achievement evaluation sheets and self-assessment sheets. Only the acquisition of declarative knowledge is tested.

STRAIGHT SMOOTH MOVEMENT

It does not follow the flipped classroom model, in phase C the teacher is present. It is unclear and the objectives are formulated incorrectly. Soft skills are wrong. Worksheets, assessment sheets for achieving all objectives and self-assessment sheets are missing. The assessment sheets that exist are difficult for the age group to which the scenario is directed. Self-assessment is done through activities on an online platform.

ITALIAN SCENARIOS

ENERGY AND SUSTAINABILITY

It does not follow the steps of the flipped classroom. The teacher is present in every phase. There is an ambiguity as to what is done in each phase. The goals are wrong. Time is not enough. Worksheets to guide students are missing. The achievement of the objectives is not evaluated in a clear way. Evaluation sheets are missing. It is not suitable for the age group it refers to, it is for older students.

VOLCANOES

There are no worksheets. There is no assessment of teaching and no self-assessment for higher skills in Bloom's taxonomy. Not all the goals set are evaluated. Learning assessment is done through a test-competition (checks declarative knowledge). The schedule is written incorrectly.

INTRODUCTION TO ELECTRICITY

It does not follow the steps of the flipped classroom. The schedule is not written correctly. The times in the timetable and in the analytical part are not the same.

Kahoot is misguided. The quizlet asks for information that has not been taught through either theory or activities. The same activity is repeated in two phases. The dcaclab.com platform is a little difficult platform for 15 year old students. There are no worksheets, teaching evaluation sheets and self-assessment sheets. The use of too many digital tools leads to loss of time and loss of goal. The sequence of activities does not advance the goals set. There are no activities for some goals.

Discussion

The flipped classroom model has special characteristics that are often misinterpreted by the authors of the educational scenarios, resulting in the confusion of the different phases of teaching and the misuse of digital educational tools. In two scenarios of Italy, and one of Cyprus, they considered that the asynchronous phase is the online course and the synchronous phase the course in the classroom, so the teacher is present almost in all phases and directs the students. This created scenarios that are in need of several corrections.

Also, in some scenarios, students are directed to use the computer for long hours, because of the multitude of digital educational tools used, something that is not requested in the context of the flipped classroom. Flipped classroom is not an entirely digitally taught lesson instead of traditional inside classroom teaching.

Thus, we suggest some corrections which we believe will improve the scenarios and increase their educational value.

GREEK SCENARIOS

REFRACTION

• Put more apparent uplifts instead of the arrow reversal

• The definition of speed should be added to the prerequisite knowledge

ELECTRIC DIPOLES-OHM'S LAW

• To be 3 phases "before - during - after teaching in the classroom" and phase B will require two teaching hours.

• Add questions such as drawing a graph from a table of values or choosing among various graphs which one obeys Ohm's law.

CYPRIOT SCENARIOS

MEASUREMENTS - FUNDAMENTAL QUANTITIES OF MECHANICS

• To study separately each fundamental quantity. All together it will probably bring confusion to the students and there is not enough time

• Objectives must be expressed clearly and in correct terminology

• Targeted assessment with an assessment sheet, not a test or quiz

• In the alternative sentences it would be better if the students measure their office and their room and not sheets of paper because they have to apply what they learn in the classroom in everyday life.

DERIVATIVES OF MECHANICAL PHYSICAL QUANTITIES

• Express objectives with correct terminology and clarity.

•Worksheets and assessment sheets are also needed, which will check the degree of achievement of all objectives and the acquisition of skills at the higher levels of Bloom's target taxonomy as well as control of the acquisition of a positive attitude towards the Physics course.

• To fill in the prerequisites and the prerequisite knowledge, not only the prerequisite skills

• The scenario is not applicable as a flipped class scenario.

• A change in schedule is needed. It slips out of time.

STRAIGHT SMOOTH MOVEMENT

• Fix the scenario to follow the flipped classroom model

• Smaller theory sheet and fix some theory mistakes in it

• More and smaller activities for children of this age.

• The evaluation sheet entered at the end of phase A should be entered at the end of phase B and a simpler one should be entered here

• The objectives should be clear and with the correct terminology

• Add a self-assessment and skills assessment sheet for skills at the upper levels of Bloom's target taxonomy

ITALIAN SCENARIOS

ENERGY AND SUSTAINABILITY

• Add worksheets to accompany the videos

• The objectives should be clearer and with the correct terminology

• In soft skills there are some skills that do not belong to them

• The schedule needs to be fixed

• Better time and phase management.

• Activity 4 to move to phase B.

• Phase B needs more work or better organization in terms of conducting the debate so that the students get the most out of it

• Self-evaluation to be at the end and to be improved

• Add teaching-evaluation sheets and skills assessment sheet for skills at the upper levels of Bloom's target taxonomy

VOLCANOES

• Include worksheet in phase A to help students where to focus their attention and what to learn

• Correct the schedule, put everything in the correct column and provide all the information

• Add teaching-evaluation sheets and skills assessment sheet for skills at the upper levels of Bloom's target taxonomy

INTRODUCTION TO ELECTRICITY

• In the materials column put only the materials and all the information should be passed to the Description column

• Use phet Colorado in place of dcaclab.com

• Use worksheets along with the video1 to help students pick out the information-knowledge they need through the abundance of information

• To use the real laboratory as well

• The 3rd activity in phase A to move to phase B

• More targeted assessment

Conclusion

The Greek scenarios have clear text, the objectives are clearly formulated and it becomes clear what the intended learning outcomes are. There is relevance of the objectives to the teaching subject-module. The sequence of activities is such that it promotes the objectives set. The time allotted is sufficient to complete each activity, except perhaps worksheet 2 in the STUDY OF ELECTRICAL CIRCUITS-CONNECTING RESISTORS scenario. The processes selected are suitable for students of the age specified by the authors. The scenarios are suitable for the instructional technique of the flipped classroom. The general philosophy of the three scenarios and the activities they contain coincide with the proposed teaching of the course defined by the Physics curriculum. They activate prerequisite knowledge and emphasize declarative knowledge according to the curriculum and additionally lead to the development of skills at the higher levels of Bloom's target taxonomy. Learning materials and learning resources help to complete the scenario activities except perhaps some in the REFRACTION scenario. The activities of all three scenarios contribute to active learning and cooperation between students - teacher and students with each other. The evaluation method of all three scenarios is in line with modern pedagogical considerations and checks the degree of achievement of the goals that have been set.

The three scenarios are easily applied in the educational process and will help students to better understand the topics - concepts they deal with. They engage students in the experimental process, help deepen understanding of concepts, and give some ideas beyond what is contained in the textbook.

Limitations or difficulties in their implementation are the need for many PCs or tablets for the virtual labs that are not sure to be available at that time in all schools and also the need for some materials, such as Plexiglas, laser, round protractors, which are usually missing in a school laboratory.

The Cypriot scenarios have ambiguities. The objectives are not clearly stated and it is not made clear what the intended learning outcomes are. The soft skills are wrong. There is no relevance of the objectives to the teaching subject-module. The sequence of activities does not advance all the goals set. The time allotted is insufficient to complete each activity. The processes selected are appropriate for students of the age specified by the authors except for the STRAIGHT SMOOTH MOVEMENT scenario. The scenarios are suitable for the flipped classroom teaching method after some improvements. The general philosophy of the three scenarios and the activities they contain coincide with the proposed didactic of the course defined by the Physics curriculum (except that of the STRAIGHT SMOOTH MOVEMENT at least for the Greek and Italian Curriculum). They activate prerequisite knowledge and emphasize declarative knowledge according to the curriculum; however they do not lead to the development of skills at the higher levels of Bloom's taxonomy of objectives. Learning materials and learning resources help complete the scenario’s activities. The activities of all three scenarios contribute to active learning and cooperation between students - teacher and students with each other. The evaluation method of all three scenarios does not coincide with modern pedagogical considerations and does not check the degree of achievement of the learning outcomes that have been set. It only checks the acquisition of declarative knowledge.

The three scenarios are implemented in the educational process as scenarios of the flipped classroom model as long as the ambiguities in what should be done and what should be achieved with some activities by the students are corrected.

Limitations or difficulties in their implementation are the need for more time to carry out so many activities. Also a limitation comes from the need for many PCs or tablets for the virtual labs which are not guaranteed to be available at that time in all schools. Finally, the scenario for the STRAIGHT SMOOTH MOVEMENT is quite demanding in terms of time and thinking for the students for whom it is intended.

The Italian scenarios have textual clarity, the objectives are clearly formulated and it becomes clear what the intended learning outcomes are. There is relevance of the objectives to the teaching subject-module. The sequence of activities is such that it promotes the objectives set in the VOLCANOES scenario and ENERGY AND SUSTAINABILITY. The same is not the case in the INTRODUCTION IN ELECTRICITY. The time allotted is not sufficient to complete each activity. The processes selected are suitable for students of the age set by the authors except for the ENERGY AND SUSTAINABILITY scenario where it requires an older age.

Both scenarios are not suitable for the flipped classroom teaching technique. The Volcanoes scenario is suitable. The general philosophy of the three scenarios and the activities they contain coincide with the proposed teaching of the course defined by the Physics Curriculum. They activate prerequisite knowledge and emphasize declarative knowledge according to the Curriculum. The VOLCANOES scenario leads to the development of skills at the higher levels of Bloom's target taxonomy. However, the development of skills at the higher levels of Bloom's target taxonomy is not checked in any scenario with a self-assessment sheet.

The learning materials and learning resources help complete the scenario activities except perhaps some in the INTRODUCTION TO ELECTRICITY scenario. The activities of all three scenarios contribute to active learning and cooperation between students - teacher and students with each other.

The evaluation method of all three scenarios does not coincide with modern pedagogical considerations and does not check the degree of achievement of the goals that have been set.

The three scenarios are not easily applied in the educational process. They need changes in some parts of them. They have some activities that will help students to better understand the topics – concepts that they deal with only if they become improved by adding worksheets and assessment sheets. They exercise students in learning through play or virtual lab and argumentation through debate.

Limitations or difficulties in their implementation are that they require much more time to be implemented in the classroom than in the teaching hours and that students must know how to use the virtual laboratory to be able to use it quickly and efficiently.

Reviews on the educational scenarios developed for Foreign Language

Georgia Gyftoula, georgyftoula@enl.uoa.gr

English Language Teacher, 3rd Primary School of Zografou, Ph.D.c. NKUA,

An overview of the educational scenarios

	Title	Topic	Target age group	Language level	Time allocation	Digital Media
1	To connect or not to connect?	Human Relationships	14-15	B1+	30΄-45΄-60΄	Platforms such as e-class, e-me, Canva, WordArt
2	Graffiti and Street Art: Controversial Artistic Expression	Art (Graffiti and Street Art)	14-15	B1+	45΄-90΄-45΄	Platforms such as e-me, e-class and SparkAdobe, Sutori, BeFunky MindMup
3	Sports, Hobbies and Leisure	Sports, Hobbies and Leisure	13-14	A2	30΄-60΄-45΄	Google Meet, Google Forms, Genially
4	Present Perfect: Presentation	Present Perfect	13-14	A2	45΄-60΄-45΄	Google Meet platform, Google Forms

	Title	Topic	Target age group	Language level	Time allocation	Digital Media
5	Summer Plans	Summer plans	13-14	A2	30΄-55΄-90΄	Microsoft Teams Platform
6	Camping, to the future	Camping	14-15	B1	45΄-80΄-45΄	Microsoft Teams platform, PowerPoint presentation with links to interactive exercises, Quizizz, Flipgrid, Framapad
7	Are conditionals associated with badluck?	Superstitions	14-15	B1	45΄-80΄-45΄	Microsoft Teams platform, PowerPoint presentation with links to interactive exercises, Canva, Flipgrid
8	Phobias	Phobias	14-15	B1	45΄-90΄-60΄	Teams platform, PowerPoint, Wordwall, Quizlet, Canva, WordArt,

Criteria in Use

A. General criteria

- Coherent and clear structure, content matching the aim and objectives set, rationale according tothe proposed methodology, smooth transition of activities, wise time allocation, good connection with the target group age and characteristics (language level, interests)

B. Specific pedagogic criteria

- Appropriacy for the Flipped Classroom technique, adhering to the teaching guidelines for the subject, promotion of higher rank skills (critical, metacognitive thinking)
- Supporting new knowledge
- Contribution to active learning (learn by doing)
- Integrating resources which favour and support the expected outcome
- Strengthening the teacher-learners bonds

Strengths and Weaknesses

Strengths

- In accordance to the template and guidelines
- Engaging topics
- Manageable activities
- Integration of digital tools
- Time allocated for the evaluation of the procedure

Weaknesses (rather points to reconsider)

- Digital tools to be used to promote collaboration and interaction among learners
- More Action-oriented approach (AoA) activities
- Time allocation issues

Inquiry-based learning: A teaching approach to enhance students' conceptual understanding and science process skills.

Konstantinos Apostolopoulos (1) , constantinos.apostolopoulos@gmail.com

Panagiotis Pefanis (2) , panpefgr@gmail.com

(1) Education Coordinator for Science
(2) Education Coordinator for Science

Abstract

Inquiry-based teaching and learning is gaining ground in modern science curricula. In this study, the basic characteristics of inquiry teaching and learning are presented, with an emphasis on science process skills and the phases of the method. Moreover, literature on the effectiveness of the method and the difficulties of its application are discussed.

Keywords: Science courses, inquiry teaching and learning, scientific processes, science process skills, phases of inquiry.

Introduction

Science teaching in Greece and in some European countries retains strong elements of the traditional/teacher-centered model of knowledge transfer. Scientific models and their related theories are initially presented to students as unquestionable truths, followed by guided processing of their structural elements, with the main aim of demonstrating the correctness of the model and its consolidation through answering questions and solving exercises and problems, which, generally, are not related to the student's everyday life or to significant technological applications in society. In other words, an academic - productive approach is preferred. Similar considerations apply to the science laboratory, although it has an important role in science teaching, it is usually limited to laboratory exercises in which the worksheets guide the students very thoroughly to achieve a result known in advance, with the main aim to confirm the correctness of the presented model/theory.

This approach deviates from modern teaching approaches and at the same time is at odds with the way Science works and develops.

Considering that, modern societies develop in an environment (OECD 2019):

a) Rapid advances in technology with an emphasis on ICT,

b) Strengthening of globalization

c) Changes in the structure of the labor-market.

As a result, there is a growing demand for workers with high-level skills that allow them to carry out projects that go beyond what A.I. systems can do. We are referring to skills that can be leveraged in a variety of jobs such as collaboration, critical thinking, creativity and innovation, decision making, communicating in different socio-cultural environments, problem solving, time management, accountability, etc.

In conclusion, school today (UNESCO 1999):

a) It cannot be based on knowledge transfer models, since knowledge is growing at a rate that the school cannot keep up with and is available to the citizen whenever he/she needs it through modern technological means.

b) It must not confine the student to a passive role in the learning and assessment process, but must help the student to develop the competencies and skills mentioned above.

An important attempt to change the above teaching approaches is inquiry-based teaching and learning. Inquiry-based learning prioritizes the active participation of the learner in the learning process, and the assumption of responsibility for the construction of new knowledge

Students as young scientists follow similar methods and practices in order to construct knowledge (Keselman 2003).

The inquiry approach seeks to teach students to systematically use the rules of logic and the processes of science to verify concepts and ideas (Massialas, 1989:331).

Science process skills

There is no standard "scientific method" that scientists in the various fields of science follow in order to make scientific discoveries. Nevertheless, research practice in different fields of science is characterized by many common parameters, which in educational practice are called scientific processes. These processes help students to develop skills (observation, classification, measurement, interpreting data and evidence, etc.) that are useful to them not only in Science but in all dimensions of their everyday life (Xalkia, 2010).

These skills are referred to as scientific process skills, are appropriate for many Science courses and usually are classified into two types, basic and integrated (NARST 1990; Brotherton & Preece 1995; Derilo 2019).

The basic skills includes:

- Observing

- Inferring

- Measuring

- Classifying

- Communicating

- Predicting

The level of integrated scientific methodology skills includes:

- Calculating[5]

- Formulating hypotheses

- Controlling variables

- Defining operationally

- Experimenting

- Interpreting data - organizing data and drawing conclusions from them

The features and the degree of students' "inquiry autonomy" depends on the extent to which students have practiced such scientific skills and at their age.

Features	Teacher Centered (A)	Teacher Driven (B)	Teacher Guided (C)	**Student Centered (D)**
1. Learners engages in a scientifically oriented question	Question provided by teacher, materials, or another source	Learner sharpens or clarifies question provided by teacher, materials, or another source	Learner selects among questions, poses new questions	**Learner poses a question**
2. Learners gives priority to evidence in responding to questions	Data provided by teacher and told how to analyze	Data provided by teacher and asked to analyze	Learner directed to collect certain data	Learner determines what constitutes evidence and collects it
3. Learners formulates explanations from evidence	Evidence provided by teacher	Learner given possible ways to use evidence to formulate explanation	Learner guided in the process of formulating explanation from evidence	Learner formulates explanation after summarizing evidence
4. Learners connects explanation to scientific knowledge	All connections provided by teacher	Possible connections provided by teacher	Learner directed toward areas and sources of scientific knowledge	Learner independently examines other resources and forms the links to explanations
5. Learners communicates and justifies explanations	Step and procedures for communication provided by teacher	Broad guidelines to sharpen presentation provided by teacher	Learner coached in development of communication	Learner formulates reasonable and logical argument to communicate explanation

(Adapted from: National Research Council. 2000. Inquiry and the National Science Education Standards, A Guide for Teaching and Learning. Washington, DC: National Academy Press, P. 29)

[5] Calculating, in the sense of using appropriate mathematical equations to determine the value of a quantity from the value of another known or measured quantity, usually is classified as integrated scientific process skill.

The context of inquiry teaching and learning

In inquiry teaching and learning the unit starts with the observation of an interesting phenomenon and after some discussion an appropriate research question/problem is formulated. It is a simple, accessible question, relevant to what has been taught and assimilated so far, which should be linked to students' everyday life in a way that stimulates their interest.

Students then carry out a rather short inquiry in order to find an answer to the question/problem.

More generally, inquiry teaching proceeds in phases.

Kalkanis et al. (2013) propose the following five phases as exactly corresponding to the steps of the scientific method:

I observe, I am informed, I am interested

I discuss, I wonder, I formulate hypothesis

I act, I am experimenting,

I conclude, I record

I apply, I interpret , I generalize

Xalkia (2010) describes the following three steps:

Designing the inquiry: Appropriate modification of the initial question, identifying and controlling variables, formulating predictions, selecting and using appropriate laboratory materials and equipment, knowing safety rules and controlling potential hazards in the laboratory.

Data collection and presentation: Specifying the method of data collection, taking measurements in the laboratory or in a virtual laboratory, recording the data.

Data evaluation: Finding regularities and correlations, interpreting the data, drawing conclusions and evaluating the process (significance of findings and limitations).

In Pathway, Ragiadakos (2011) describes the phases of the guided research model as follows:

Phase 1. Turning the phenomenon into a problem. Presentation by the teacher, and discussion with the students.

Phase 2. Suggestions for dealing with the problem. Students formulate hypotheses, predictions and suggestions for dealing with the problem.

Phase 3. Implementation of a proposal. Students set up the experiment with teacher support, make measurements and record their findings.

Phase 4. Interpretation of the findings. Comparison of findings with the prediction and discussion of theoretical issues/themes arising from the experimental activities.

Phase 5. Consolidation. The teacher asks questions and assigns tasks in order to consolidate the acquired knowledge.

Pedaste et al. (2015) describe five general phases with strong links between them and an emphasis on communication and reflection:

Orientation. The process of stimulating curiosity about a topic and addressing a learning challenge through a problem statement.

Conceptualization The process of stating theory-based questions and/or hypotheses.

Investigation. The process of planning exploration or experimentation, collecting and analyzing data based on the experimental design or exploration.

Conclusion. The process of drawing conclusions from the data. Comparing inferences made based on data with hypotheses or research questions.

Discussion. The process of presenting findings of particular phases or the whole inquiry cycle by communicating with others and/or controlling the whole learning process or its phases by engaging in reflective activities.

Findings from the implementation of the model - Conclusions

The inquiry approach, when linked to students' everyday experience, has a number of positive effects on the teaching-learning process, such as (Mao, Chang, & Barufaldi 1988; Anderson, 2002; Yager & AcKay 2010; Pathway, 2012; Friesen & Scott, 2013; Harlen, 2013; Salinitri, Palazzolo, et al., 2018)

- increasing conceptual understanding,

- fostering critical thinking and creativity

- developing more positive attitudes towards science,

- increasing the capacity to transfer knowledge,

- motivating students to explore and interpret phenomena around them using rational scientific processes,

- fostering science process skills

- strengthening cooperation and communication skills

According to research, an important element for improving students' performance is the strong involvement of students in group activities to investigate questions or problems (Ates & Eryilmaz 2011; Bilgin 2006; Hofstein & Lunetta 2004; Walters and Soyibo, 2001).

Inquiry-based teaching and learning in science lessons is a key term in the European Commission's influential document "Science Education NOW: a renewed pedagogy for Europe's future" (EC, 2007). The report argues that inquiry-based teaching and learning in science subjects is effective with all students, from the weakest to the most able, and is fully compatible with the ambition of excellence. In addition, it is beneficial in promoting girls' interest and participation in science activities." (EC, 2007)

In a relatively different direction are the findings of PISA 2015 (OECD 2016: 36 & 64, Cairns 2019), regarding the correlation between the effectiveness of the teaching practices included in the PISA 2015 inquiry teaching scale and students' responses to the PISA 2015 items. Specifically, teaching practices that included strong teacher guidance were associated with high student performance, while practices that included systematic engagement of students in creating their own research questions, experiments and conclusions were associated with either low performance or no significant correlation.

Nevertheless, inquiry-based teaching and learning is positively associated with interest in science, cognitive beliefs and motivation for future science-oriented careers “across OECD countries, more frequent inquiry-based teaching is positively related to students holding stronger epistemic beliefs and being more likely to expect to work in a science-related occupation when they are 30" (OECD 2016:36).

Also, Cairns reports that students who conduct experiments in the laboratory for some teaching hours have higher achievement scores than students who conduct experiments for all teaching hours and concludes that the laboratory inquiry approach is encouraged, but should be done in moderation to allow time to achieve consolidation of conceptual understanding. Students need to reflect on their experiences of laboratory exploration in order to master abstract scientific knowledge.

Finally, in the direction of supporting inquiry-based teaching and learning, the constraining factors that seem to prevent teachers from implementing inquiry-based experimental activities should not be overlooked. Indicatively mentioned (Stasinakis, 2022):

a) Absence of appropriate educational material in school textbooks.

b) Lack of relevant teacher training.

c) Large number of students per class.

d) Limited number of teaching hours for science lessons in the weekly timetable.

e) Insufficient laboratory equipment and limited availability of consumables.

f) Lack of time for laboratory preparation and the absence of support during the laboratory experiments.

(g) Lack of student interest in the inquiry approach.

References

Anderson, D.R. (2002). Reforming Science Teaching: What Research says about Inquiry. *Journal of Science Teacher Education, 13(1), 1-12.*

Ates, O., & Eryilmaz A. (2011). Effectiveness of hands-on and minds-on activities on students' achievement and attitudes towards physics. Asia-Pacific Forum on Science Learning and Teaching, Volume 12, Issue 1, Article 6, p.1.

Bilgin, I. (2006). The effects of hands-on activities incorporating a cooperative learning approach on eighth grade students' science process skills and attitudes towards science. *Journal of Baltic Science Education, 1(9), 27-37.*

Brotherton, P.N., & Preece P.F.W. (1995) Science Process Skills: their nature and interrelationships. Research in Science & Technological Education, 13:1, 5-11.

Derilo, R.C. (2019). Basic and Integrated Science Process Skills Acquisition and Science Achievement of Seventh-grade Learners. European Journal of Education Studies, 6(1), pp. 281-294.

EC (2007). Science Education Now: A renewed pedagogy for the future of Europe, (The Rocard report), Brussels: European Commission, EC. https://ec.europa.eu/research/science-society/document_library/pdf_06/report-rocard-on-science-education_en.pdf.

Friesen, S., & Scott, D. (2013). Inquiry-Based Learning: A Review of the Research Literature. Paper for the Alberta Ministry of Education (Canada). Ανακτήθηκε από https://galileo.org/focus-on-inquirylit-review.pdf.

Harlen, W. (1999). Purposes and procedures for assessing science process skills. Assessment in Education, 6, 129-144.

Harlen, W. (2013). Inquiry-based learning in science and mathematics. *Review of Science, Mathematics and ICT Education, 7(2), 9-33.*

Hofstein, A. & Lunetta, V. N. (2004). The laboratory in science education: foundations for the twenty-first century. Science Education, 88, 28-54.

Kalkanis, G. et al., (2013). Physics through Experiences -1st Grade-Secondary School. CTI Diophantus.

Keselman, A. (2003). Supporting Inquiry Learning by Promoting Normative Understanding of Multivariable Causality. Journal of Research in Science Teaching, 40 (9), pp. 898–921.

Mao, S-L., Chang, C-Y., & Barufaldi, P.J. (1988). Inquiry Teaching and Its Effects on Secondary-School Students' Learning of Earth Science Concepts. *Journal of Geoscience Education, 46(4), pp. 363-367.*

Massialas, B. (1989). Pedagogical Psychological Encyclopedia, Vol.1. Greek Literature. Athens (in Greek).

NARST (1990). The Science Process Skills. Recovered from: https://narst.org/research-matters/science-process-skills.

OECD (2016). PISA 2015 Results (Volume II): Policies and Practices for Successful Schools. Paris: OECD Publishing.

OECD (2019), Skills Matter: Additional Results from the Survey of Adult Skills, OECD Skills Studies, OECD Publishing, Paris, https://doi.org/10.1787/1f029d8f-en.

Pathway (2012). Inquiry Journey to Physics Teaching. Teacher's Guide. Recovered from: http://www.pi-schools.gr/programs/pathway/index.php?ep=5.

Pedaste, M., Mäeots, M., Siiman, L.A., de Jong, T., van Riesen, S.A.N., Kamp, E.T., Manoli, C.C., Zacharia, Z.C., Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. Educational Research Review 14, pp 47–61.

Ragiadakos,, X. (2011). PATHWAY - Basic features of Inquiry Based learning and Teaching. Recovered from: http://www.pi-schools.gr/programs/pathway/index.php?ep=5 (in Greek).

Salinitri, G., Palazzolo, S, Nahaiciuc, R., Iacobelli, E., Yuanrong, L., & Zhou, G. (2018). Analysis of Canadian Inquiry-based Science Teaching Practices and its Implications for Reciprocal Learning. *Universal Journal of Educational Research, 6(10), pp. 2280-2293.*

Stasinakis, P.K. (2022). Inquiry Based Learning and Skills' Development at the Biology Lab in Secondary Education In: Kampourakis K. "Didactics of Biology" (in Greek).

UNESCO (1999). The treasure inside education. Athens. Gutenberg.

Xalkia, K. (2010). Teaching Physical Sciences. Theoretical Issues-Questions and Suggestions. Vol.1. Patakis. Athens (in Greek).

Yager, E.R. & AcKay, H. (2010). The Advantages of an Inquiry Approach for Science Instruction in Middle Grades. *School Science and Mathematics 110(1), 5-12.*

Walters, Y. B. & Soyibo, K. (2001). An analysis of high school students' performance on five integrated science process skills. Research in Science & Technological Education, 19, 133-145.

EUROPEAN MULTIPLIER EVENT PROCEEDINGS

. eTwinning and Digital Transformation
. Students' Performance Prediction-Moodle Analytics
. Digital Literacy
. Collaborative Inquiry
. The 3-D Inquiry Model
. Peer assessment

The role of eTwinning in the digital transformation of Education

Michael Paraskevas [(1)], mparask@cti.gr

Chrysa Kapralou [(2)], kapralou@cti.gr

Nikolaos Tzimopoulos [(3)], ntzimop@sch.gr

[(1)] *Head of Hellenic NSO eTwinning, Vice President of CTI "Diophantus" Assoc. Professor at University of Peloponnese,*

[(2)] *Vice Head of Hellenic NSO eTwinning, CTI "Diophantus"*

[(3)] *Member of Hellenic NSO eTwinning*

Abstract

This paper presents the results of the implementation of the European eTwinning action, in Greece, for more than 15 years. In particular, the strategy followed by the national support organization of the eTwinning action in Greece will be presented in order to strengthen the skills of teachers and students, implementing actions that include open online courses, MOOCs, STEM actions to introduce students and teachers to Educational Robotics, connection with Universities and National Organizations, to targeted teacher trainings, seminars and actions to find partners at the European level.

Keywords: eTwinning, digital skills, online courses, MOOCs, STEM, Robotics

1. Introduction

The eTwinning is a flagship action of the European Commission. More than one million teachers from European schools, which exceed 230,000 in number from 44 countries, participate in it. Among them, more than 13,000 Greek schools and more than 40,000 Greek teachers participate, who have created almost 21,000 collaborative projects.

Responsible for the eTwinning in Greece is the Hellenic National Support Organization (NSO) that operates with collaboration of Ministry of Education and Religious Affairs (MERA[6]) and Computer Technology Institute and Press "Diophantus" (CTI[7]). The CTI is the technological pillar of the MERA for ICT and textbook publishers. It carries out research and development in ICTs with an emphasis on Education and it develops and operates important national educational infrastructures, such as the Greek School Network, e-government applications for administration of school education system, educational platforms and repositories of educational content, while providing teacher training and various certifications.

2. Organization and Strategy Plan

The eTwinning pedagogy, with the integration of innovative approaches to teaching and learning and entrepreneurship in education, develops skills such as complex problem solving, learning by doing, critical thinking, creativity, empathy, accountability, emotional intelligence,

[6] https://minedu.gov.gr
[7] https://www.cti.gr/en/

wellbeing, cognitive flexibility, ICT literacy, entrepreneurship and readiness for life-long learning. Effective methods of blending different learning spaces (indoors and outdoors, labs & open spaces, physical & virtual/flipped classroom) create engaging learning experiences and familiarize learners with good practices that foster quality learning environments and bridge culture and science, art, and technology in authentic real-world learning.

To achieve these main goals as well as meet core organizational objectives, and priorities for the period 2020-2022, the Hellenic NSO, which is responsible for developing and supporting important educational actions that cover a wide range, focuses mainly on cultivating the digital skills of teachers and students and it has designed and followed its own strategic plan. This plan includes actions of open online courses, STEM actions to introduce students and teachers to Educational Robotics, targeted teacher training, seminars and partner-finding actions at the European level and many other actions, as will be described in the following section.

Also, Hellenic NSO has developed a communication plan in order to promote events and actions organized at a national level both to eTwinners and to the wider educational community (i.e. teachers not registered in eTwinning, parents, pupils, educational authorities etc.). Moreover, it is noteworthy that all the events organized by the Hellenic NSO were supported and promoted by the MERA as well as the Regional Directorates of Primary and Secondary Education through press releases published on their websites and circulars sent to all teachers of primary and secondary education, thus significantly increasing eTwinning visibility in Greece.

3. The actions of eTwinning in Greece (2019-2022)

The Hellenic NSO of eTwinning provides continuous pedagogical and technical support to Greek teachers through the following actions:

Online courses and distance learning action

These are online courses aimed at the "Pedagogical use of ICT and Web 2.0 tools, educational robotics (STEM) and mobile devices for the implementation of collaborative activities in eTwinning projects and their integration into the teaching of lessons". They are offered free of charge to teachers attracting high interest (for this school year more than 15,000 teachers have registered) and receiving excellent evaluations from participants. The subject matter of the courses includes learning platforms, educational material production tools, collaborative and teaching supportive tools, developing critical thinking about digital content, teaching using mobile devices, Scratch programming, educational robotics at all levels of schools, etc. All the trainers involved are voluntary and the online courses are completely free for the trainees. Each online course's support team writes, posts, proofreads and updates the training materials, creates and coordinates the online classes, and resolves learner issues. At the same time, the team of trainers & graders (consisting of 500 volunteer trainers) motivate the trainees and grade the activities they prepare. Every week the material of a new teaching unit is posted and the participants are asked to submit activities related to the respective unit. The content of the online courses is co-shaped by the whole community through the completion of questionnaires. The oldest trainees participate as trainers. Upon successful completion of each online course, which consists of the successful submission of at least 70% of assignments, each learner can retrieve their attendance certificate from the e-learning platform. The training material remains permanently available for all trainees. Online courses are conducted exclusively using distance learning techniques and methods. For the asynchronous part, the internationally established Moodle platform is used, while for the modern part, the e-learning platform BigBlueButton is used, both based on open software. These platforms are hosted by the Greek School Network (GSN).

"Staying at Home with eTwinning" action

With the sudden suspension of school operations in March 2020 due to the Covid-19 pandemic and targeting to familiarizing teachers with distance education as quickly as possible, the Hellenic NSO created and immediately offered three specialized online courses: “Distance education - Communication tools - Collaboration tools – Advice” (21,956 teachers participated), “GSN Educational Communities & Blogs”, “GSN Electronic School Classroom”, (9,185 teachers participated). Hellenic NSO also organized three webinars with experts on topics related to how to deal with Covid-19 (psychological support - mental health of teachers / students, maintaining the well-being of students, etc.), by invitation throughout the educational community available to eTwinners and the wider Greek educational community. Finally, Hellenic NSO co-organized a distance conference together with other bodies (EELLAK and Universities) on the topic of distance education, which was attended by more than 6,000 educators.

STEM/eTwinning action

The purpose of this action is to introduce teachers and students to Educational Robotics, with the exciting learning of physics, technology, engineering and mathematics (STEM). The action aims at the transformation from traditional teacher-centered teaching to teaching in which problem solving, exploratory learning and the creative involvement of learners play a dominant role. A practical approach is applied, and methods of analysis and problem solving are used without focusing on theories and unnecessary terminology. At the same time, it is possible to develop creativity skills, algorithmic & programming solutions and to cultivate team spirit through collaboration. The selection of schools in the STEM action is made by open call and evaluation with eTwinning criteria (e.g. number of projects undertaken in the last two years, percentage of active eTwinners teachers per school, national and European quality labels received, etc.). The selected schools receive appropriate robotics equipment (depending on the level of education) and 3D printers as well as training and support services, with the aim of utilizing the equipment to create similar projects, oriented towards STEM education. The number of beneficiary schools per school year is: (a) 2017 – 2018: 110 schools, (b) 2019 – 2020: 280 schools and (c) 2021 – 2022: 245 schools. Totally 635 schools.

National eTwinning Conference

The Hellenic NSO of eTwinning successfully organizes the annual eTwinners conference on "Using ICT in Cooperative School Programs for Primary and Secondary Education"every year, which is the culmination of the activity of eTwinners teachers. Six (6) national conferences have been held since 2014, with a particularly large participation of teachers and an impact on the educational community. At the national eTwinning conference, proposals are presented, which are accepted after a judging process, which have topics related to the implementation of eTwinning projects but also the use of ICT in the implementation of these projects. About 50-60 proposals are presented. At the same time, many workshops are implemented on the subject of eTwinning tools, the use of educational robotics, the development of digital skills, etc. Papers presented at conferences are published in proceedings with an ISBN. The first five (5) conferences that were implemented live were attended by more than 600 teachers each. The 6th national conference was implemented remotely due to Covid-19 and was attended by more than 2,000 educators. The 7th National Conference[8] was implemented online from 19 to 21 November 2021. During the conferences there is a special award ceremony for schools and teachers who have won national eTwinning awards in the corresponding annual national competition.

Professional Development Workshops

The Professional Development Workshops (PDW) are organized by the National Support Organizations (NSOs) and the Central Support Service (CSS) and concern specific specialties, thematic units or solar groups. The main objective of the Workshops is the professional training of teachers, such as their training in ICT, cooperative learning through eTwinning and others. Indicatively, on 29/9 – 1/10/2021, the Professional Development Workshop entitled, "Media Literacy Education in Early Childhood Education and Care" will be implemented, which is addressed to Greek and foreign eTwinners teachers of preschool education and in which distinguished speakers will participate from Greece and abroad, workshops will be held on the topic of Media Literacy in preschool age, by Greek ambassadors and foreign experts, and examples of good practices will be presented by award-winning Greek and foreign eTwinners educators.

Cooperation with Universities

In collaboration with the Central Support Service (CSS), the Hellenic NSO of eTwinning piloted the participation of pedagogical university departments in eTwinning with the aim of informing and training students on issues related to the use of ICT in the educational process, distance education, collaboration and the development of teachers' skills related to the use of ICT. Seven university departments have already participated, while from the following academic year the action will be extended to other Universities of the country.

Cooperation with the State Scholarship Foundation (IKY)

In the context of the permanent and close cooperation of Hellenic NSO of eTwinning with the National Coordination Unit of Erasmus+ actions operated by the State Scholarship Foundation (I.K.Y.), the Hellenic NSO of eTwinning promotes the educational programs of I.K.Y. and the E.U. and in particular mobility plans (Key Action 1) and strategic partnerships (Key Action 2) through active communication channels. In addition, the eTwinning.net portal allows the interactive enrichment of the activities implemented in the framework of the above actions and can be used: (a) To search for partners for KA2 Erasmus+ Strategic Partnerships between schools, (b) To search for host schools and educational institutions for teaching and/or teacher training through job shadowing / training in the framework of Action KA1 of Erasmus+, (c) As a means of communicating with project partners, (d) As an online class that connects students to each other, (e) As a means of disseminating project results and ensuring their sustainability, and (f) As a document archive. At the same time, Hellenic NSO of eTwinning participates with its executives in I.K.Y. and correspondingly invites executives of the National Unit I.KY. in the national eTwinning conferences it organizes.

[8] http://www.etwinning.gr/conf2021

Cooperation with National Center for Public Administration and Local Government (EKDDA)

The Hellenic NSO of eTwinning offers free to teachers through the National Center for Public Administration and Local Government (EKDDA) special course for the introduction to the eTwinning action. The course is offered nationwide by Hellenic NSO of eTwinning through the 24 Regional Educational Training Centers.

Support for the "Skills Labs" action

The "Skills Labs " are a new institution of educational innovation that joined Greek school education. The Hellenic NSO of eTwinning with its know-how, experience, rich educational material and above all with the human network of teachers it has, aspires to support teachers who wish to implement a "Skills Labs" in a collaborative way. For this purpose, there is collaboration with the IEP and MERA in order to promote to teachers the design and implementation of "skills workshops" programs through eTwinning platform, with relevant guidance and support, such as a MOOC named “eTwinning & Skills Labs: Collaborative actions to cultivate knowledge, skills and abilities”. This is the first Massive Open Online Course designed and coordinated by Hellenic NSO of eTwinning and the aim of this course was to train teachers on how to make good use of the network, tools and educational materials provided by the eTwinning platform when implementing the “Skills Labs” action. The course was offered in spring 2022 and was open to all pre-primary, primary and secondary teachers. The course was divided into four modules and required an attendance time of approximately 20 hours. About 4000 teachers have successfully attended this MOOC.

Cooperation with the "National Academy of Digital Skills"

The wealth of digital educational content, the long-term experience and the organization that Hellenic NSO of eTwinning allow it to respond quickly and qualitatively to emblematic actions of Greek state bodies, such as “National Academy of Digital Skills”. The “National Academy of Digital Skills” is an initiative of the Ministry of Digital Governance to develop and gather educational content, in one entry point, aiming to develop the digital skills of all levels of citizens. In order to strengthen the digital skills of citizens the Hellenic NSO of eTwinning responded to a call from the Ministry of Digital Governance by offering nine digital courses, which can be accessed by all citizens. These courses are: “Intellectual property”, “Digital Profile - Digital Reputation”, “Evaluation of websites”, “Google Maps & Street View”, “Storage in the cloud (Dropbox)”, “Doodle – Event Planning”, “Skype”, “Electronic commerce” and “Mobile phones and tablets: I know the device”.

Multilateral Seminars

The Hellenic NSO of eTwinning in its effort to give as many professional development opportunities as possible to the teachers participating in the action, organizes Partner Finding Seminars to find partners. In these seminars, teachers have the opportunity to learn about eTwinning and other tools, learn how to organize a collaborative project and most importantly meet and collaborate with colleagues from other countries.

Campaigns and contests

Special promotions are implemented, such as the “eTwinning weeks”, the “spring campaign”, etc., through which teachers are invited to participate in various activities, e.g. to create a project with a specific theme, take part in online games, webinars, etc., with a prize for their participation in various professional development opportunities (seminars, conferences inside and outside Greece).

Good practice guide

The award-winning projects of the action are presented every two years in a curated publication, which is distributed to schools and available for free online (via the official site).

4. Results

eTwinning recognizes the efforts of participating teachers and their students by awarding the most successful projects the European and National Prizes, European and National Quality Labels (NQL). Schools that display a strong commitment to shared leadership and are recognized as leaders in digital and eSafety practice can receive the eTwinning School Label.

NQL applications at the national level for the year 2019 evaluation period (this year's evaluation took place throughout the year for NQL applications submitted from 01/09/2018 until 31/08/2019) have been a total of 852. 558 of the Greek teachers who participated in European eTwinning projects and applied for a NQL have been awarded the national quality label, while 262 were rejected, mostly, due to lack of necessary information to support the evaluation process. 147 out of 852 applications were submitted by teachers who worked on National eTwinning projects. 110 of them have been awarded a QL and 12 of these applications were rejected.

NQL applications at national level for the year 2020 evaluation period (June-October 2020) have been a total of 1179. 537 of the Greek teachers who participated in European eTwinning projects and applied for a NQL have been awarded the national quality label, while 575 were rejected. 65 out of 1179 applications were submitted by teachers who worked on National eTwinning projects. 8 of them have been awarded a NQL and 57 of these applications were rejected.

Finally, NQL applications at national level for the year 2021 evaluation period (June-October 2021) have been a total of 1097. 685 of the Greek teachers who participated in European eTwinning projects and applied for a NQL have been awarded the national quality label, while 282 were rejected. 130 out of 1097 applications were submitted by teachers who worked on National eTwinning projects. 59 of them have been awarded a NQL and 71 of these applications were rejected.

5. Conclusion

The eTwinning is a well-organized action of the European Commission, which has been widely accepted by the educational community in Greece. Greek teachers make use of the tools and educational content (lesson plans, videos, good practices) created by the eTwinning action for all school levels, including Early Childhood Education and Care (ECEC) and Vocational Education and Training (VET).

6. References

Alexiou, L. (2019). Teaching mathematical concepts using web-based collaborative environments. An eTwinning case study. Journal of Open Education 15(1), 111-124.

Bacescu, M. C. (2016). eTwinning - The community for schools in Europe. In: I. Roceanu (Ed.), 12th International Scientific Conference 'eLearning and Software for Education' - eLearning Vision 2020, Volume II, 21-22 April 2016 (pp. 194-199). Bucharest: "Carol I" National Defense University Publishing House.

Camilleri, R.-a. (2016). Global education and intercultural awareness in eTwinning. Cogent Education, 3(1), 1210489. DOI: 10.1080/2331186X.2016.1210489

Cassells, D., Gilleran, A., Morvan, C., & Scimeca, S. (2015). eTwinning generation, celebrating ten years of eTwinning. Brussels: Central Support Service of eTwinning-European Schoolnet.

Crawley, C., Gilleran, A., Scimeca, S., Vuorikari, R., & Wastiau, P. (2009). Beyond school projects: A report on eTwinning 2008-2009. Brussels: Central Support Service of eTwinning-European Schoolnet.

Crawley, C., Gerhard, P., Gilleran, A., & Joyce, A. (Eds.). (2010). eTwinning 2.0: Building the community for schools in Europe. Brussels: Central Support Service of eTwinning-European Schoolnet.

European Commission. (2013b). Study of the impact of eTwinning on participating pupils, teachers and schools. Luxemburg: Publications Office of the European Union. https://op.europa.eu/en/publication-detail/-/publication/ec23d4e3 -e305 -4d1c-83da-1989d35ec7e0.

Fat, S. (2012). The impact study of eTwinning projects in Romania. In: I. Roceanu (Ed.), 8th International Scientific Conference "eLearning and Software for Education", Volume I, 26-27 April 2012 (pp. 152-156). Bucharest: Editura Universitara.

Galvin, C. (2009). eTwinning in the classroom: A showcase of good practice (2008-2009). Brussels: Central Support Service of eTwinning-European Schoolnet.

Galvin, C., Gilleran, A., Hogenbirk, P., Hunya, M., Selinger, M., & Zeidler, B. (2007). Reflections on eTwinning: Cultural understanding and integration professional development. Brussels: eTwinning Central Support Service.

Gilleran, A. (2019). eTwinning in an era of change: Impact on teachers' practice, skills, and professional development opportunities, as reported by eTwinners. Brussels: Central Support Service of eTwinning-European Schoolnet.

Gilleran, A., & Kearney, C. (2014). Developing pupil competences through eTwinning. Brussels: Central Support Service of eTwinning-European Schoolnet.

Gilleran, A., Pateraki, I., Scimeca, S., & Morvan, C. (2017). eTwinning Book: Building a culture of inclusion through eTwinning. Brussels: Central Support Service of eTwinning-European Schoolnet.

Holmes, B. (2013). School teachers’ continuous professional development in an online learning community: lessons from a case study of an eTwinning Learning Event. European Journal of Education, 48(1), 97-112.

Kampylis, P., Bocconi, S., & Punie, Y. (2012). Fostering innovative pedagogical practices through online networks: the case of eTwinning. In: J. Valtanen, E. Berki, M. Ruohonen, J. Uhomoibhi, M. Ross & G. Staples (Eds.), INSPIRE XVII – Education matters, 21-23 August 2012 (pp. 17-28), University of Tampere.

Kampylis, P., & Punie, Y. (2013). Case report 1: eTwinning - the community for schools in Europe. In: P. Kampylis, N. Law & Y. Punie (Eds.), ICT-enabled innovation for learning in Europe and Asia (pp. 21-35). Luxemburg: Publications Office of the European Union.

Kane, G. (2011). Exploring the benefits of participating in an eTwinning project for small collaborative groups in a primary classroom setting - Case Study. University of Limerick, Limerick. https://ulir.ul.ie/handle/10344/1820 (10/12/19).

Kearney, C., & Gras-Velázquez, À. (2015). eTwinning Ten Years On: Impact on teachers’ practice, skills, and professional development opportunities, as reported by eTwinners. Brussels: Central Support Service of eTwinning-European Schoolnet.

Kearney, C. (2016). Monitoring eTwinning practice: A pilot activity guiding teachers’ competence development. Brussels: Central Support Service of eTwinning-European Schoolnet.

Kearney, C., & Gras-Velázquez, À. (2018). eTwinning Twelve Years On: Impact on teachers’ practice, skills, and professional development opportunities, as reported by eTwinners. Brussels: Central Support Service of eTwinning-European Schoolnet.

Lenc, A., Žagar Pečjak, M., Šraj, U., & Abramič, M. (2016). Study of the impact of the eTwinning programme on school education in Slovenia. Ljubljana: Centre of the Republic of Slovenia for Mobility and European Educational and Training Programmes.

Manfredini, E. The contribution of eTwinning to innovation–mathematics, science and technology (MST).In: A. Ceccherelli & A. Tosi (Eds.), Key Competences in Lifelong Learning - Cultural Expression, Science and Citizenship: some eTwinning success stories, 22-23 November 2007 (pp. 21-28). Florence: Grafiche Gelli Firenze.

Nawrot-Lis, B. (2018). The impact of eTwinning projects on teachers’ professional development in the context of the English and Polish educational system. EduAkcja. Magazyn Edukacji Elektronicznej, 1(15), 23-40.

Papadakis, S. (2016). Creativity and innovation in European education. Ten years eTwinning. Past, present and the future. International Journal of Technology Enhanced Learning, 8(3-4), 279-296.

Pateraki, I. (2018a). eTwinning and its relation to cultural heritage. In: I. Pateraki & S. Scimeca (Eds.), Learning from the past, designing our future: Europe's cultural heritage through eTwinning (pp. 14-36). Brussels: Central Support Service of eTwinning-European Schoolnet.

Pateraki, I. (2018b). Measuring the impact of eTwinning activities on teachers’ practice and competence development. Brussels: Central Support Service of eTwinning-European Schoolnet.

Pietrzak, A. (2009). Significance and development of the eTwinning programme in Poland as compared to other European countries. In E. Gajek, & P. Poszytek (Eds.), eTwinning - A way to education of the future (pp.11-30). Warsaw: Foundation for the Development of the Education System.

Silva, M. P. C. (2013). “Learning from One Another” eTwinning project: A model of an intercultural approach to using ICT in foreign language teaching. In: P.M. Pumilia-Gnarini, E. Favaron, E. Pacetti, J. Bishop & L. Guerra (Eds.), Handbook of Research on Didactic Strategies and Technologies for Education: Incorporating Advancements (pp. 170-181). Hershey: IGI Global.

Valls Cassí, C. (2014). eTtwinning project: a way to motivate young EFL learners (Bachelor thesis). Universitat de Vic - Universitat Central de Catalunya, Vic. http://repositori.uvic.cat/handle/10854/3373.

Velea, S. (2011). ICT in education: responsible use or a fashionable practice. The impact of eTwinning action on the education process. In: Proceedings of the 6th International Conference on Virtual Learning, 28-29 October 2011 (141-144). Bucharest: University of Bucharest Publishing House.

Vuorikari, R., Kampylis, P., Scimeca, S., & Punie, Y. (2015). Scaling up teacher networks across and within European schools: The case of eTwinning. In: C-K. Looi, L.W. Teh (Eds.), Scaling Educational Innovations (pp. 227-254). Singapore: Springer.

Predicting Students' Performance using Moodle Analytics-The "CONNECT" approach

Ioannis Georgakopoulos [1], igtei@uniwa.gr

Vassilis Zakopoulos [2] , v.zakopoulos@uniwa.gr

[1] Informatics Teacher, Associate and Researcher at the University of West Attica

[2] Laboratory Teaching Staff at the University of West Attica

Abstract

This article focuses attention on cardinal Moodle Analytics engagement data that could be analyzed in order to predict students' performance in blended courses. The research indicates that a proper analysis of the aforementioned data could result in the generation of a competent prediction model for students at risk.

Keywords: Moodle Analytics, students at risk, prediction model, blended courses

1. Introduction

There is not so much measurable data in regard to students' engagement that could be collected in conventional teaching. The data that could be easily measured in conventional teaching is related to students' absences and grades [1,2,3,4]. In this sense, it is not easy to predict students' performance in conventional teaching. However, the "CONNECT '' approach, which suggests blended learning, offers the solution. In terms of blended courses, a part of the learning design is implemented on a LMS such as Moodle in order to take advantage of the LMS analytics. In the case of Moodle, there are a lot of meaningful things that could be analyzed with a view to predicting students' performance [2,3.4.5]. This paper focuses attention on these data and shows the way they could be analyzed to come up with a potent prediction model.

2. Method

Our method includes a process that could be carried out in a sequence of steps [6,7]:

1. Decide which part of the course will be mounted on Moodle.

2. Collect all the requisite engagement data with respect to the course activities on Moodle.

3. Analyze the data in terms of statistical or machine-based techniques in order to come up with a prediction model.

In most cases, we decide to mount on Moodle the part of the course with the graded activities aiming at relating the activities' completion to students' grades. However, not graded activities could also be part of a specific course implementation on Moodle. For instance, Forum could be viewed as an activity that is not graded but there is Moodle meaningful data in regard to such activity. The table below lists some of the most popular Moodle Analytics data in terms of students' engagement: [6,7.8,10,11,12].

Table 1: Moodle Analytics Engagement Data

Total logins into the system
Total number of activities completed
Total number of resources viewed
Total posts on Forum
Total messages sent by students through the system
Total time allotted to the system
Total time allotted to a specific activity completion
Total number of self-evaluation exercises completed
Grades on quizzes, assignments and other activities

It is important to underline that it is not easy to collect the aforementioned data for each course. Therefore, the "CONNECT" approach attenuates the role of "learning design" in order to create appropriate activities with a view to collecting the respective data. From another perspective, it is essential to lay emphasis on the fact that the engagement data that could be collected depend on the course structure [5,6,7,8,9].

After collecting the requisite data, statistical techniques based on significant factors such as (logistics regression, linear regression and discriminant function analysis) along with machine-based techniques (Bayesian-Neural networks, classifiers) could be employed to generate the prediction model [3, 5,6,7,8,9,10,11,12].

3. Results

The paper stresses the potential of the discriminant function analysis. In detail, specific course activities were designed to be implemented on Moodle in order to collect some of the aforementioned data listed in Table 1. This data set was employed in terms of a discriminant function analysis with a view to generating a competent prediction model for students at risk (predicting students' negative final outcome) [5,6,7,8,9,10]. The discriminant function analysis outcome was two linear functions calculated at the end of the course and with the help of which students were classified into students at risk and into students not at risk. The maximum score of the underlying functions for each student defined the student classification group [5,6,7,8,9,10].

The functions are listed below:

Students (not at risk):

Y1=3.405 * Total number of multimedia material studied + 2.654 * Total number of self-assessment exercises completed +0.764 * Total posts in forum-24.922.

Students (at risk):

Y2=2155 * Total number of multimedia material studied + 1.792 * Total number of self-assessment exercises completed +0.607 * Total posts in forum-14.052.

It is important to underline that the coefficients of the respective functions are the risk factors of the underlying blended course. It is also essential to denote that the risk factors are identified after the first course-run and the respective discriminant functions constitute a prediction model which comes into effect after the first course-run and works well in any subsequent course-run.

Finally, it is important to clarify that the same process could be followed to generate a prediction model for any blended course sharing the same structure. Though, we cannot rule out the possibility of emerging risk factors [2,5,6,7,8,9,10].

4. Conclusion

The paper indicates that blended courses favor students' performance prediction. The role of the learning design is cardinal in order to create appropriate activities with the help of which meaningful e-learning data could be measured in regard to students' engagement. The analysis of such data results in a prediction model. In this light, the "CONNECT" approach appears to contribute to students' performance prediction by placing emphasis on blended learning and Moodle Analytics.

5. References

[1]. Georgakopoulos, I., Chalikias, M., Zakopoulos, V., & Kossieri, E. (2020). Identifying factors of students' failure in blended courses by analyzing students' engagement data. *Education Sciences*, *10*(9), 242.

[2]. Georgakopoulos, I., Kytagias, C., Psaromiligkos, Y., & Voudouri, A. (2018). Identifying risks factors of students' failure in e-learning systems: Towards a warning system. *International Journal of Decision Support Systems*, *3*(3-4), 190-206.

[3]. Anagnostopoulos, T., Kytagias, C., Xanthopoulos, T., Georgakopoulos, I., Salmon, I., & Psaromiligkos, Y. (2020, June). Intelligent predictive analytics for identifying students at risk of failure in Moodle courses. In *International Conference on Intelligent Tutoring Systems* (pp. 152-162). Springer, Cham.

[4]. Georgakopoulos, I., Chalikias, M. S., Zakopoulos, V., & Kossieri, E. (2020). Identifying Factors which Critically Affect Students' Failure in Blended Courses. In *HAICTA* (pp. 12-18).

[5]. Georgakopoulos, I., & Tsakirtzis, S. (2021). Generating a Model to Predict Secondary School Students at Risk in Mathematics. *International Electronic Journal of Mathematics Education*, *16*(2).

[6]. Tsakirtzis, S., & Georgakopoulos, I. (2020). Developing a Risk Model to identify factors which critically affect Secondary School students' performance in Mathematics. *Journal for Mathematics Education and Teaching Practices*, *1*(2), 63-72.

[7]. Zakopoulos, V., Georgakopoulos, I., Kossieri, E., & Kallivokas, D. (2021). Controlling Attrition in Blended Courses by Identifying Students at Risk: A Case Study on MS-Teams. *International Journal of Finance, Insurance and Risk Management*, *9*(3), 57-68.

[8]. Zakopoulos, V., Georgakopoulos, I., & Kontaxaki, P. (2022). Developing a risk model to control attrition by analyzing students' academic and nonacademic data.

[9]. Georgakopoulos, I., Piromalis, D., Makrygiannis, P. S., Zakopoulos, V., & Drosos, C. (2022). A Robust Risk Model to Identify Factors that Affect Students' Critical Achievement in Remote Lab Courses. *International Journal of Economics & Business Administration (IJEBA)*, *10*(3), 3-22.

[10]. Georgakopoulos, I. D., Kytagias, C. D., Liomas, I., Psaromiligkos, Y., & Voudouri, A. Identifying Defects in Learning Design through a Risk Analysis Process based on Learning Analytics. *UNDER THE AUSPICES*, 104.

[11]. Zakopoulos, V. (2022). A Framework to Identify Students at Risk in Blended Business Informatics Courses: A Case Study on Moodle. *International Journal of Economics & Business Administration (IJEBA)*, *10*(1), 239-247.

[12]. Macfadyen, L. P., & Dawson, S. (2010). Mining LMS data to develop an "early warning system" for educators: A proof of concept. *Computers & education*, *54*(2), 588-599.0.

Policies for digital literacy and education

Bessie Mitsikopoulou , mbessie@enl.uoa.gr

National and Kapodistrian University of Athens

Abstract

The integration of digital literacy in education is a complex phenomenon which requires changes at a number of different levels. One of them refers to the development of students' and teachers' digital competence. The paper examines the case of digital competence in large scale European frameworks and supports the view that they can be a springboard for the development of national strategies and local educational policies. In addition, it claims that digital competence is the first necessary step towards the digital transformation in education and presents the example of a state curriculum which explicitly introduces digital competence in its goals.

Keywords: digital literacy, digital competence, European frameworks, curriculum

1. Introduction

Over the last forty years we have experienced a fundamental change in how we approach the use of technology in the classroom. In the 1980s the question posed by teachers was how can I use technology in my classroom to make my lesson more interesting and motivating for my learners?' drew on an instrumental discourse of technology which viewed digital technologies as neutral tools that could be used to 'aid' teaching and learning. Forty years later, the questions which are now posed are quite different: 'how can I integrate digital literacy in my classroom? How will this integration affect my teaching and what changes will this bring?' These are much more complex questions to answer which draw on the emergent concept of digital literacy and the major changes in the ways we communicate today (Mitsikopoulou, 2022). To respond to these questions, this text suggests that the integration of digital literacy in education requires, among others, policy initiatives that explicitly introduce digital literacy as part of their goals; and that these policy initiatives affect policy documents and consequently classroom practices.

Extending above technical skills, the notion of digital literacy has been variously defined. Martin (2008) conceptualizes it in terms of three distinct levels. The first, the *digital competence level*, includes a combination of digital techniques, skills, concepts, approaches, attitudes, etc. The second level, *digital usage*, refers to contextual and appropriate application of digital tools in various disciplines, and the third level, *digital transformation*, refers to critical reflection and the transformative social impact of digital actions. While it is actually in this third level that innovation and creativity are enabled and significant change in the professional or knowledge domain is achieved, a lot of attention has been based on the development of the first level, that of *digital competence*, viewed as a prerequisite first step for the successful implementation of the other two levels.

Although in practice the notions of digital literacy and digital competence have often been used interchangeably, the notion of digital literacy has primarily been used in scholarly research, while the notion of digital competence has dominated policy documents. Actually, the term digital competence first appeared in policy documents and later in research and academic publications. Concerned primarily with policy making, digital competence has been characterized as a political term related to the developments of digital media and technologies in specific domains, such as education, as well as the political aims and expectations of citizenship in the digital era (Ilomäki et al., 2016).

A large-scale policy initiative of the European Union which placed particular emphasis on enhancing digital competences for the digital transformation is the Digital Education Action Plan (2021-2027). This Action Plan was designed in order to promote a common vision of inclusive and accessible digital education in Europe and to support the adaptation of education to the digital age. The Action Plan has identified two priorities for the development of a high performing digital education ecosystem with the one being the enhancement of digital competences. Several related actions have been identified for this priority, such as the development of common guidelines for teachers and educators to foster digital literacy through education and the update of the Digital Competence Framework for Citizens.

2. European frameworks for digital competence

2.1 The Digital Competence Framework for Citizens

The *Digital Competence Framework for Citizens,* known by the acronym DigComp, was first published by the Joint Research Centre (JRC) of the European Commission in 2013 and its latest version, DigComp 2.2, was updated in 2022, under the Digital Education Action Plan Framework (Vuorikari, Kluzer & Punie, 2022). In the context of this framework digital competence is defined as the confident, critical, creative and responsible use of, and engagement with, digital technologies for learning, work, employment, leisure, inclusion and participation in society (Ferrari, 2012). As stated in the framework, DigComp aims to develop a tool for better understanding of digital competence in terms of the knowledge, skills and attitudes which are required in order for someone to be a digitally literate citizen; to develop digital competence descriptors that will form a conceptual framework; and to propose a roadmap for the use of the framework in education and other domains. The Framework identifies five competence areas (information and data literacy, communication and collaboration, digital content creation, safety, and problem solving) and 21 competences across eight proficiency levels (see Figure 1).

The particular interest for education is directed into DigComp 2.2 that explicitly includes students as one of the groups which the Framework addresses and for this reason it proposes that it can be variously used for policy formulation and support, for instructional planning (e.g. training syllabus for digital competence in adult education), and for assessment (e.g. an assessment tool to assess one's digital competence). Below we will examine a case in which the illustrative descriptors (can-do statements) outlined in this Framework have been used to specify digital literacy descriptors in a foreign language curriculum.

Figure 1: Competence areas of DigComp 2.2 (Vuorikari, Kluzer & Punie, 2022, p. 7)[9]

In addition, the Framework introduces a number of use cases in the form of examples and learning scenarios for each one of the identified competences. For example, in the fifth competence area, that of problem solving, the first competence refers to 'solving technical problems', namely 'to identify technical problems when operating devices and using digital environments, and to solve them' (Vuorikari, Kluzer & Punie, 2022, p. 119). The use cases section offers two scenarios, one employment and one learning scenario, which refer to the specific competence. The learning scenario is titled 'Use of a digital learning platform to improve my math skills', and its level and illustrative descriptors in the form of can-do statements are presented below:

Competence area 5: Problem solving

Competence 5.1: Solving technical problems

Use case

Learning scenario: Use of a digital learning platform to improve my math skills
Foundation level 1: helped by a friend

I can identify a simple technical problem from a list of those that can arise while using a digital learning platform, and

I can identify what type of IT support would solve it.

(Vuorikari, Kluzer & Punie, 2022, p. 120)

2.2 The European Framework for the Digital Competence of Educators

While DigComp introduced a framework for general digital competence, the *European Framework for the Digital Competence of Educators*, known by the acronym DigCompEdu, describes what it means for educators to be digitally competent. It aims at developing a framework for teachers' digital competence and a coherent model that would allow teachers

[9] Reproduced from DigComp under Creative Commons Attribution 4.0 (CC BY 4.0).

at all levels of education "to comprehensively assess and develop their pedagogical digital competence" (Redecker, 2017, p. 13). This framework, which is based on work carried out by the European Commission's Joint Research Centre (JRC), aspires to become a tool for continuous professional development among teachers of all specializations in different parts of Europe. One of the interesting features of DigCompEdu is that it does not focus on teachers' technical skills but on the role of digital competences to enhance innovative education through the use of digital media and technologies.

DigCompEdu includes 22 competences which are explained in six stages informing the users about their level: what they have achieved and what the next steps include if they decide to further develop the specific competence. As is the case with other descriptors, they are positive, describing achievements and making explicit the stages through which each competence develops. The 22 competences are organized in the following six areas:

Area 1: Professional engagement, using digital technologies for communication, collaboration (with colleagues, learners and their families) and professional development

Area 2: Digital resources, sourcing, creating and sharing digital resources for learning

Area 3: Teaching and learning, managing and orchestrating the use of digital technologies in teaching and learning

Area 4: Assessment, using digital technologies and strategies to enhance learners' formative and summative assessment

Area 5: Empowering learners, using digital technologies to enhance inclusion, personalization and learners' active engagement

Area 6: Facilitating learners' digital competence, enabling learners to creatively and responsibly use digital technologies for information, communication, collaboration and participation (Redecker, 2017, p. 31)

From these six areas the first refers to teachers' professional competences, Areas 2 to 5 are centered around educators' pedagogic competences (what teachers need to know in terms of digital resources, teaching and learning, assessment, and empowering learners to foster effective, inclusive and innovative learning), while Area 6 concerns teachers' actions to facilitate their learners' digital competences preparing them for creative and responsible use of digital technologies (Figure 2). This last area is quite significant since it brings to the foreground the work of all teachers, irrespective of their specialization, to develop their learners' digital competences.

Another interesting feature of the framework is that it describes different levels of digital competence development using the six proficiency levels of the Common European Framework of Reference for Languages (CEFR). Taking into account that the CEFR levels (ranging from A1 to C2) are well known and widely used all over the world, the JRC group selected this taxonomy on the assumption that it would be easier for teachers to understand their personal level of digital competence by reference to the well-known CEFR proficiency levels. According to Redecker (2017), 'since educators know that their language competence levels may differ when comparing, e.g. their listening, speaking and writing skills, it will be natural for them to accept that their digital competence has to be appreciated by area and may differ widely from one area to another' (p. 28).

Figure 2: The DigCompEdu framework (Redecker, 2017, p. 15)[10]

The six stages of the progression model are the following: Newcomer (A1), Explorer (A2), Integrator (B1), Expert (B2), Leader (C1), Pioneer (C2). In the first two stages (A level), educators "assimilate new information and develop basic digital practices", in the following two stages (B level) they "apply, further expand and reflect on their digital practices", while in the highest stages (C level) educators "pass on their knowledge, critique existing practice and develop new practices" (Redecker, 2017, p. 29).

The framework has been used as the basis for a number of other tools. One of them, 'SELFIE for Teachers', is a free online self-assessment tool developed by the European Commission as part of the Digital Educational Action Plan (2021-2027). The tool was developed to allow primary and secondary teachers to reflect on their digital competence along the six areas identified above and to review how they are using technology in their professional practice. After the completion of a series of questions on technology use, teachers receive a report which indicates their level of competence (from A1 newcomer to C2 pioneer) in each one of the six areas. As is often the case with language proficiency levels, here too users may exhibit different levels of competence in different areas. This tool can function as a good starting point for teachers to identify strengths and weaknesses, facilitating future training programs of professional development. The use of both the DigCompEdu and its tool, together with other similar tools have already been used in different parts of Europe and their implementation will be much encouraged in the next few years.

2.3. From European frameworks to state curricula

The European frameworks and tools developed as a result of large-scale policy initiatives, such as the Digital Education Action Plan, were designed with the purpose to affect local state policies and the outlining of policy documents, such as local curricula. An example in case is the recent Greek Foreign Languages Curriculum for Upper Secondary Education (2021). As stated in its introduction:

> Taking into account that a significant part of the communication among teenagers today is conducted through the use of new technologies, the curriculum attempts to connect

[10] Reproduced from DigCompEdu under Creative Commons Attribution 4.0 (CC BY 4.0).

the communicative competence in the foreign language with the digital literacy of the General Lyceum students. (p. 5)

In addition to language curriculum aims, the new foreign languages curriculum for lyceum integrates illustrative descriptors (in the form of can-do statements) which have been drawn from the descriptors of two European Frameworks. Specifically, the curriculum outlines descriptors for online communication which are drawn from the DigComp Framework described above. In addition, the curriculum draws on the descriptors of the Common European Framework of Reference for Language (CEFR), the most widely used language proficiency document impacting language policies and curricula worldwide (Figueras, 2012), whose recent publication, the CEFR Companion Volume (CoE, 2020) introduced for the first time two illustrative scales with descriptors for online communication. In fact, contrary to the original version of the CEFR (CoE, 2001), which makes no reference to digitality or multimodality, the recent Companion Volume recognizes the importance of online interaction as a multimodal phenomenon and develops illustrative descriptors for online conversation and discussion, and goal-oriented online transactions and collaboration. Descriptors from these two frameworks for digital literacy and online communication have been incorporated in the foreign languages curriculum, illustrating in this way how curricula may be affected by broader policy initiatives.

Figure 3 illustrates the trail from the Digital Education Action Plan to the Digital Competence Framework for Citizens and from there to a local state curriculum.

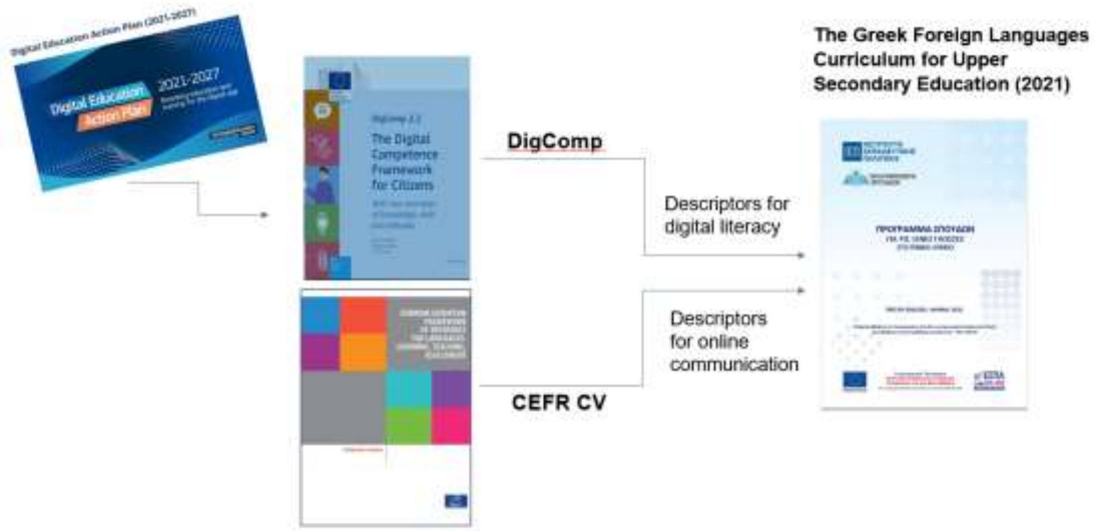


Figure 3: The trail of digital literacies in curricula: A showcase

3. Conclusion

In this brief text we have examined how the concept of digital competence for students and teachers has systematically been addressed through large-scale policy initiatives and how these initiatives at European level may affect state educational policies, such as curricula. We should keep in mind though that the incorporation of digital literacy descriptors in curricula may be an important first step towards the integration of digital literacy in education, but not the only one. There are many more steps to be taken. One of them refers to the alignment of digital literacy policies at different levels (Mitsikopoulou, 2022), for instance between curricula and high-stakes examinations. In a recent article, Unsworth, Cope and Nicholls (2019) suggest that the digital literacies included in the Australian national curriculum should also be incorporated in the testing items of the national exams, and they refer to an 'educational chasm' between the curriculum and the testing system that needs to be addressed. They argue that assessment practices need to be consistent with the corresponding curriculum requirements.

Similar alignment is required at the level of classroom practices. Influenced by curricula which introduce digital literacies, teachers may include in their syllabus the teaching of specific digital genres. This, however, should also be accompanied by assessment practices which take into account the digital nature of the specific genres. Aagaard (2014) notes that teachers often turn to established assessment practices of verbal genres and do not take into account the digital nature of texts their students may produce. As a result, teachers may find themselves in a position in which they teach a digital genre (e.g. a digital story), but they evaluate their students' production of that genre with assessment criteria used in verbal texts.

It is obvious that the incorporation of digital literacies in education is multi-faceted. The development of students' and teachers' digital competence presented in this paper is just one of the many dimensions that need to be addressed in the process of the digital transformation of education.

4. References

Aagaard, T. (2014). Teachers' approaches to digital stories. Tensions between new genres and established assessment criteria. *Nordic Journal of Digital Literacy, 9*(3), 194-215.

Council of Europe (CoE). (2001). *Common European Framework of Reference for Languages: Learning, teaching, assessment*. Strasbourg: Council of Europe.

Council of Europe (CoE). (2020). *Common European Framework of Reference for Languages: Learning, teaching, assessment. Companion Volume with New Descriptors*. Strasbourg: Council of Europe.

Ferrari, A. (2012). *Digital competence in practice: An analysis of frameworks*. JRC Technical Reports. Luxembourg: Publications Office of the European Union.

Figueras, N. (2012). The impact of the CEFR. *ELT Journal, 66*(4), 477-485.

Ilomäki, L., Paavola, S., Lakkala, M., & Kantosalo, A. (2016). Digital competence: An emergent boundary concept for policy and educational research. *Education and Information Technologies, 21*(3), 655-679.

Institute of Educational Policy (IEP). (2021). Foreign Languages Curriculum for General Lyceum (in Greek). Athens: IEP.

Martin, A. (2008). Digital literacy and the 'digital society'. In C. Lankshear & M. Knobel (Eds), *Digital Literacies: Concepts, policies and practices* (pp. 151-176). New York: Peter Lang.

Mitsikopoulou, B. (2022). *Digital Media in Foreign Language Education*. Athens: Pedio.

Redecker, C. (2017). *European Framework for the digital competence of educators: DigCompEdu*. Y. Punie (Ed.), EUR 28775 EN. Luxembourg: Publications Office of the European Union.

Unsworth, L., Cope, J., & Nicholls, L. (2019). Multimodal literacy and large-scale literacy tests: Curriculum relevance and responsibility. *Australian Journal of Language and Literacy, 42*(2), 128-140.

Vuorikari, R., Kluzer, S. and Punie, Y. (2022). DigComp 2.2: The Digital Competence Framework for Citizens - With new examples of knowledge, skills and attitudes. Luxembourg: Publications Office of the European Union, Luxembourg.

Teaching and learning as collaborative inquiry and meaning-making process

Panagiotis Piliouras(1) , ppiliouras@iep.edu.gr

Vasiliki Ioakimidou(2) , v.ioakimidou@iep.edu.gr

(1) Consultant A', Institute of Educational Policy
(2) Consultant B', Institute of Educational Policy

Abstract

Socio-cultural pedagogical approaches emphasize the important role of social and cultural context in the appropriation of knowledge by students, and argue that learning is not an exclusively individual function of cognition, but a socio-cultural process that takes place through communication and interaction with other people. The sociocultural shift in education has led to the development of approaches that are oriented towards seeking to implement collaborative inquiry environments. A key factor facilitating this way of organizing and managing the classroom is the modification of the role of the teacher exclusively from a knowledge agent to a coordinator of students' actions and activities. In the formation of desirable collaborative inquiry environments, an important role is played by the way groups are formed, the engagement of their members in appropriate learning projects, the guidance of the groups and the facilitation of communication between them. Collaborative inquiry learning environments require teachers who are aware that through their involvement in the learning process students form and appropriate their own understandings of the subjects (e.g. science), the nature of their learning and teaching, the nature of subjects' language, based on their beliefs, opinions and the cultural practices they bring to the classroom.

Keywords: socio-cultural approaches, collaborative inquiry, role of the teacher

1. Introduction

In recent decades, a wide range of theoretical perspectives have highlighted the social character of the cognitive process and the crucial role of language and verbal interaction in the transformation and appropriation of knowledge in the context of the teaching and learning process (Roth, 1995; Wells 1999; Lemke 2001; Carlsen, 2013).

Based on emerging socio-cultural assumptions, theorists and practitioners argue that schools should offer more opportunities for students to negotiate in their own context and in the context of the subjects taught, to argue, reach agreements and value the views of others being engaged in appropriately designed collaborative inquiry-based activities (Wells 1999). Sociocultural pedagogical approaches emphasize the important role that the social and cultural context plays in students' construction or appropriation of knowledge, and argue that learning is not an exclusively individual function of cognition, but a sociocultural process that takes place through communication and interaction with other people.

The first key assumption of the sociocultural approach is the recognition of the social character of the cognitive process (Wertsch, Del Rio & Alvarez, 1995). This assumption orients and guides choices in the learning process. It suggests that a collaborative inquiry learning environment should be sought to develop, where the exploration of opinions and questions/problems is promoted. Socio-cultural approaches invite us to view participants in the learning process not as a collection of individuals but as a community working to achieve common goals, and this success is largely dependent on the level of collaboration. In this context, learning is seen as a gradual but not cumulative process of acquiring/developing expertise through participation in appropriately designed collaborative activities which offer the possibility for progressive construction/appropriation, application and transformation of knowledge. Indeed, while exclusively cognitive-oriented theories consider the cognitive process as an activity that takes place exclusively in the minds of individuals, socio-cultural theories do not separate the cognitive process from the social context from which it takes place and therefore always consider it in the context of a specific social action.

A second assumption is that learning in the context of sociocultural approaches is understood as a transformation of participation in collaborative inquiry-based learning activities (Wells & Claxton, 2002; Rogoff, 2003). Based on this view, learning/development is not a static but dynamic process and thus needs to be addressed, studied and researched. If students have never worked collaboratively or if teachers have never collaboratively led a class based on this framework, it probably means that they have never engaged in these practices and therefore should not be blamed for not mastering them.

A third assumption of the sociocultural approach is the significant position and crucial role of language and verbal interaction in the transformation and appropriation of knowledge (Wells, 1999; Mortimer & Scott, 2003). For sociocultural approaches, the active participation of the learners in the interactions and the type of interactions that take place during the learning process are determinants of the type of learning they will appropriate. This assumption leads the learning process towards an approach that should be oriented towards examining the discourses/communicative actions of teachers and learners that emerge/take place during the instruction.

A fourth assumption is the meaning of literacy adopted by sociocultural approaches (Roth & Lee, 2003). For them, the development of scientific literacy requires conditions of social negotiation of knowledge, creation of inquiry-based learning communities and is directly dependent on the context in which the teaching and learning process takes place.

The emergence of collaborative inquiry approaches:

The socio-cultural shift in education has led to the development of approaches that are oriented towards the pursuit of collaborative inquiry environments.

In 1992, Rosebery et al. developed a collaborative inquiry approach to teach foreign language learners (Collaborative Scientific Inquiry in Language Minority Classrooms). Their approach was based on the premise that since authentic scientific practices are in fact a collaborative inquiry in nature approach, learning environments should be structured in the same way. A key aim of this approach was for students to gradually develop scientific discourse. In particular, it sought to develop argumentation skills and, through participation in collaborative inquiry activities, to provide students with the experiences of participating in investigations and building their own personal meanings.

Bereiter and Scardamilia (1995) suggest the creation of communities of inquiry or knowledge building communities. The position put forward by Bereiter and Scardamilia (1995) is that schools should function as communities in which knowledge takes place as a collective endeavor. They introduced the term "progressive discourse" to describe the process through which the formulation, informing of all, clarification and revision of views within the interactions that take place in a community of inquiry leads to "a new understanding" that everyone involved in the process agrees is superior to their own previous understanding (Bereiterm, 1994; Land, & Jonassen, 2012).

Another approach that has emerged in this context is that of collaborative problem solving. Roth, a proponent of the collaborative problem-solving approach, stresses the crucial role of language in the learning process when students solve problems together and notes that activities should be designed to allow the emergence of child-centered language games that enable students to use language appropriately (Roth, 1995; Roth et al. 2019).

Another relevant orientation is that of dialogic inquiry whose main proponent is Wells (1999). Wells advocates "the creation of a collaborative community of practice in which, through facilitated participation in appropriate activities, students experience a process of semiotic apprenticeship as they reconstruct cultural tools with a view to responsible and creative living in given local and wider social contexts" (1999, p. 137).

Finally, we will refer to the 'thinking together' research project based on the work of Mercer and his colleagues on talk and dialogue in the context of group collaboration (Mercer, 1995; Dawes, Mercer & Wegerif, 2000; Mercer, & Littleton, 2007). A key feature of the 'thinking together' approach is that the process of successful meaning making is directly linked to students' language/interpretive skills. Students benefit significantly when they are educated and become more aware of the linguistic resources available to them (Wegerif et al., 1999). Mercer has introduced the terms 'inter-thinking', 'thinking together') and 'co-reasoning' to focus attention on the joint, coordinated intellectual activity that students enact using language (Mercer, 2001, p. 16). A key element of the 'thinking together' programme is the pursuit of exploratory talk. Ιν αδδιτιον, according to Dawes, Mercer and Wegerif (2000), a group activity is more likely to be productive and effective if the group's functioning is based on agreed rules, which learners should not only be aware but also agree.

All of the above approaches lead us to seek for the formation of a collaborative inquiry learning environment in which motivating activities take place, where the learners are not only aware of but gradually appropriate the learning strategies they seek to develop, and the role of the teacher is crucial to the learning process and therefore requires the possibility on their part for a critical examination and reflection of the teaching repertoires they adopt.

2. Learning as meaning-making and participation in appropriately guided discourses in the context of collaborative inquiry

The assumption of learning as an effort to create meaning in the context of collaborative inquiry stems from the positions of Vygotsky, Bruner, Bakhtin, Wittgenstein, Halliday etc. (Piliouras 2006). Lemke, a key proponent of this view, reframing Bakhtin's (1981) discourse states: "If students do not speak in terms of science they will not learn science" (Lemke, 1990 & 2001). He argues that the language of science has its own semantic patterns, its own special ways of constructing meaning, and that for most people these ways are learned through participation in appropriately guided discourses during the teaching-learning process (Lemke, 2001). Whereas according to Sutton (2002) teaching is a process of introducing new ways of observing and new ways of speaking. Based on this view, teaching should be the study of systems of meanings that people have created.

Sutton (2002:149-152) refers to two conceptions of language. The first one refers to language as naming while the second refers to the use of language as an interpretive system. He states how both uses are necessary, but that the second should have a significant place in classrooms. The suggestion he makes is illustrative: "A teacher who teaches science as a scientist needs to be precise, and as a teacher needs to manage the exploration of ambiguity" (Sutton, 2002:154).

Positions such as the above call for joint exploration and negotiation of the meanings that emerge in classrooms during the teaching-learning process. In a similar socio-cultural context with Lemke and Sutton, the work of Mortimer and Scott is directed (e.g. Mortimer, 1998; Mortimer & Machado, 2000; Scott, 1998; Mortimer et al., 2012). Adopting Vygotsky's view that development and learning involve the passage from social context to individual understanding, Mortimer and Scott (2003) based on Bakhtin argue that the learning process is a dialogic process, a process of meaning-making. Agreeing with them, we can note that the processes of learning and development, and more specifically, the process of evolution of concepts, is not something that is automatically transferred from teacher to learner, but involves, for each participant, a continuous comparison and checking of his/her own views with the ideas that are being researched and emerging at a social level. This process of evolution of concepts or word meanings needs the engaged participation of the learner in appropriately designed and guided discourses by a well-informed teacher. It is this process of highlighting, comparing and differentiating meanings that we call collaborative inquiry.

Wallace & Narayan R. (2002), adopting Bhabha's (1994) theoretical concept of the "third space", advocates the creation of open inquiry environments, which offer the possibility for natural, authentic expression on the part of students in the context of the teaching-learning process. As Wallace (2004) states, the third space is in line with other theoretical conceptions such as, Bakhtin's hybrid discourse or Bereiter's (1994) progressive discourse. The strategy of developing the third space enables students to find or seek convergences between every-day and scientific language, what Lemke calls bridging colloquial and scientific discourse, what Roth calls student hybrid language games, what we call collaborative inquiry discourse. Lee (1997), in turn, has formulated the idea of "instructional congruence". This theoretical conception, too, concerns the emergence of a process of gradual appropriation by students of scientific discourse.

In conclusion, discourse-oriented approaches to education emphasize the important role of the nature and type of communicative interactions in the context of a collaborative inquiry-based learning process.

The role of the teacher in a collaborative inquiry learning environment

The way in which groups are formed, the engagement of their members in appropriate learning projects, the guidance of the groups and the facilitation of communication between them play an important role in the formation of desirable collaborative inquiry environments. A key factor in facilitating this way of organizing and managing the classroom is the change in the role of the teacher from being exclusively a knowledge provider to a coordinator of students' actions and activities. Collaborative inquiry learning environments require teachers who are aware that through their involvement in the learning process students form and appropriate their own understandings of the subjects (e.g. science), the nature of their learning and teaching, the nature of subjects' language, based on their beliefs, opinions and the cultural practices they bring to the classroom.

The diversity of students' views, experiences and different knowledge backgrounds contribute significantly to enriching the learning environment created in the classroom. In the context of classroom collaboration where students are engaged in a project where each activity aims to maximize desired interactions and active participation of students and teachers. Creating desirable conditions for collaborative inquiry requires the teacher to possess important skills such as (Piliouras 2006):

organizing and setting up team work in a class.

using a variety of techniques to lead and coordinate team work in cooperative learning conditions:

Provide necessary instructions and clarifications depending on the type (e.g. many materials-few materials, practical activity, something else) and the nature of the activity (easy-difficult) (e.g. before students carry out an activity they should be given the necessary instructions and clarifications).

Announce the time available to the groups.

The position and role of the teacher during the group activity, so that he/she acts as an additional member of the group.

Synthesis of the views in the class plenary either during the phase of elicitation of the students' views or during the phase of the realization of the learning activities.

designing and implementing learning activities suitable for collaborative learning

offering assessment opportunities and effective feedback in cooperative learning contexts.

Some micro-teaching strategies that the teacher can use in his/her pursuit of a collaborative inquiry learning environment are the following:

He/she promotes dialogue and opportunities for students to discuss creatively during lessons:

Seeks to break the dominance of the question-answer-feedback pattern.

Encourages questioning by students.

Allows time for students and groups to formulate their opinions and conclusions.

Promotes dialogue and argumentation.

Encourages the participation of all students and all groups.

Poses appropriate questions (usually open-ended).

Allows the necessary time for the implementation of activities.

He/she highlights the empirical and experiential experiences that students and groups have.

Directs the dialogue so that it takes place both in the context of the students and in the context of the subjects, looking for similarities and differences between the two contexts with his students.

Is careful when presenting scientific views to treat with respect the different views of pupils on the basis of experience, social background, religious belief or cultural origin.

Guides students or groups on how to combine as rigorously as possible desired concepts to formulate their conclusions.

He/she builds bridges between the students' colloquial language and the scientific language of the subjects.

Gives opportunities for students or groups to talk about the same phenomenon in the context of colloquial and scientific language and clearly indicates when this is the case.

Discusses with students about formal scientific language and writing but also uses non-formal approaches to introduce students to various topics (e.g., informal student strategies in mathematics and established mathematical algorithms such as adding homonymous fractions).

He/she actively engages students and groups in activities.

He/she promotes authentic inquiry to the extent allowed.

3. References

Bakhtin, M. (1981). *The Dialogic Imagination.* Austin: University of Texas Press.

Bereiter, C. (1994). Implications of Postmodernism for Science, or, Science as Progressive Discourse. *Educational Psychologist, 29(1)* ,3-12.

Bhabha, H. K. (1994). *The location of culture.* London: Routledge.

Brown & Campione (1994). Guided discovery in a community of learners. In: McGilly K (ed.) *Classroom lessons: Integrating cognitive theory and classroom practice.* Bradford Books/MIT Press, Cambridge, MA, 229–270.

Carlsen, W. S. (2013). Language and science learning. In *Handbook of research on science education* (pp. 57-74). Routledge.

Dawes, L., Mercer, N. and Wegerif, R. (2000). *Thinking Together: activities for teachers and children at Key Stage 2*. Birmingham; Questions Publishing Co.

Land, S., & Jonassen, D. (2012). *Theoretical foundations of learning environments*. Routledge.

Lee, O. (1997). Scientific literacy for all: What is it, and how can we achieve it? *Journal of Research in Science Teaching*, 34, 219–222.

Lemke, J. L. (1990). *Talking Science: Language, Learning and Values.* Norwood, NJ: Ablex Publishing Company.

Lemke, J. L. (2001) Articulating Communities: Sociocultural Perspectives on Science Education. *Journal of Research on Science Teaching 38 (3),* 296-316.

Mercer, N. (1995). *The Guided Construction of Knowledge: talk amongst teachers and learners.* Clevedon: Multilingual Matters.

Mercer, N. (2001). *Words and Minds.* London, Routledge.

Mercer, N., & Littleton, K. (2007). *Dialogue and the development of children's thinking: A sociocultural approach*. Routledge.

Mortimer, E. F. (1998). Multivoicedness and univocality in classroom discourse: An example from theory of matter. *International Journal of Science Education, 20(1),* 67-82.

Mortimer, E. F., & Machado, A. H. (2000). Anomalies and conflicts in classroom discourse. *Science Education 84(4),* 429-444.

Mortimer, E. F., Scott, P., & El-Hani, C. N. (2012). The heterogeneity of discourse in science classrooms: The conceptual profile approach. In *Second international handbook of science education* (pp. 231-246). Springer, Dordrecht.

Mortimer, E., & Scott, P. (2003). *Meaning Making in Secondary Science Classrooms*. McGraw-Hill Education (UK).

Piliouras P. (2006). Collaborative inquiry in the science class. A discourse-oriented approach. Unpublished Doctoral Dissertation, National and Kapodistrian University of Athens.

Rogoff, B. (2003). *The cultural nature of human development.* University Press: Oxford

Rosebery, A. S., Warren, B., Conant, F. R. (1992). Appropriating Scientific Discourse: Findings from Language Minority Classrooms". *Center for Research on Education, Diversity & Excellence. NCRCDSLL Research Reports*. Retrieved on 06/12/2022 from http://repositories.cdlib.org/crede/ncrcdsllresearch/rr03

Roth, W. M., Van Eijck, M., Reis, G., & Hsu, P. L. (2019). *Authentic science revisited: In praise of diversity, heterogeneity, hybridity*. Brill.

Roth, W.-M. (1995). *Authentic School Science*. Dordrecht, Boston, London: Kluwer Academic Publishers.

Roth, W-M. & Lee, S. (2003). *Science Education as/for Participation in the Community.* University of Victoria, Victoria, British Columbia, Canada V8W 3N4.

Scardamalia, M. & Bereiter, C. (1994). Computer support for knowledge building communities. *Journal of the Learning Sciences*, 3, 265-283.

Scott, P. (1998). Teacher Talk and meaning making in science classrooms: A Vygotskian analysis and review. *Studies in Science* education, 32, 45-80.

Sutton, C. (2002). Words, Science and Learning. Ed. Kokkotas P., translation Kasoutas M., & Lathouris D., Dardanos, Athens.

Wallace C. & Narayan R. (2002). Wallace C. & Narayan R. (2002). Acquiring the social language of science: Building science language identities through inquiry-based investigations. *Conference: Ontological, Epistemological, Linguistic and Pedagogical Considerations of Language and Science Literacy: Empowering Research and Informing Instruction*, University of Victoria, September 12, 2002.

Wallace, C. S. (2004). Framing new research in science literacy and language use: Authenticity, multiple discourses, and the “Third Space”. *Science Education*, *88*(6), 901-914.

Wegerif, R., Mercer, N., & Dawes, L. (1999). From social interaction to individual reasoning: An empirical investigation of a possible socio-cultural model of cognitive development. *Learning and Instruction*, 9, 493-516.

Wells G. (1999). *Dialogic Inquiry: Towards a Sociocultural Practice and Theory of Education*, New York: Cambridge University Press.

Wells, G. & Claxton, G. (Eds.), (2002). *Learning for life in the 21st century: Sociocultural perspectives on the future of education.* London: Blackwells.

Wertch, J. Del Rio, P. and Alvarez, A. (1995). Sociocultural studies: history, action and mediation, in Wertsch J., Del Rio P. and Alvarez A. (eds) *Sociocultural Studies of mind*. Cambridge: Cambridge University Press

The Inquiry Based Teaching and Learning Method and the Three Dimensional Model (3-D Model) for Scientific Literacy

Konstantinos Skordoulis [(1)], kskordul@primedu.uoa.gr

Constantina Stefanidou [(1)], sconstant@primedu.uoa,gr

Ioanna Katsiampoura [(1)], katsiaioan@primedu.uoa.gr

[(1)] *Department of Pedagogy and Primary Education, National & Kapodistrian University of Athens*

Abstract

The purpose of this paper is to present the framework for the development and introduction of inquiry learning and teaching in the educational process, the phases of inquiry teaching and the tools it uses as well as to identify the role of the teacher. In addition, the paper aims to present the advantages of this method compared to the traditional teacher-centered teaching method and the factors that lead to its effective implementation. Emphasis is placed on the contribution of the method in developing critical skills in students, and improving their performance. Finally, this paper presents the three-dimensional model proposed by the US National Research Council to improve science literacy. The paper focuses on the presentation of the crosscutting concepts that cut across the sciences and the practices that correspond to them.

Keywords: Inquiry based teaching and learning, three-dimensional model, crosscutting concepts, practices, science teaching

1. Introduction

Following the publication of the Rocard report in 2007, inquiry-based teaching was politically supported, funded and promoted by the European Union. The Rocard Report recommended the active promotion of the introduction of inquiry-based teaching approaches in schools and led to a concerted European Union commitment to inquiry-based learning models such as INQUIRE, MASCIL, PRIMAS and SAILS (Oliver et al 2021). Thus, the European Commission called for a change in the way of teaching in schools and in particular a move from traditional teaching to inquiry-based learning (NRC, 2012). In 2018, one could see the term 'inquiry' in almost any curriculum in industrially developed countries from primary to higher education and indeed this method of teaching was supported by many funding bodies, for example EU Horizon 2020. The reason is that inquiry learning contributes to the scientific literacy of tomorrow's citizens.

The aim of Inquiry Based teaching and Learning is to equip students with the skills needed to meet the demands of the 21st century. As underlined by the OECD, students need to acquire the ability to organize their own learning process, to acquire scientific knowledge by learning how to conduct investigations effectively, to develop critical thinking and problem-solving skills in order to become active members of 'civil society' and to be able to make decisions on individual and collective problems of concern to them.

At the same time, inquiry learning has been shown to have an impact on understanding and adopting a positive attitude towards science and related professions. Research has also shown that students who are engaged in science activities understand science content better than students who are taught using the traditional lecture method by the teacher (Baroudi and Helder, 2019).

The effort to adopt and develop Inquiry-based teaching and learning encounters numerous difficulties but is an extremely important goal in the context of European education policy. In the effort to specialize inquiry-based teaching for science, the three-dimensional teaching model was developed in which we will focus and present it in the following section of the paper.

2. Inquiry Based Teaching and Learning

In contrast to traditional teaching, where the teacher teaches science content mainly through lectures, the inquiry method focuses on research conducted by the students themselves, which is the driving force for learning. The inquiry learning environment promotes an active, student-centered, learning approach that incorporates students' existing alternative ideas and seeks to support processes of conceptual reconstruction (Duit and Treagust, 2003). Students gradually develop basic scientific ideas by learning how to investigate. They use skills that scientists use and learn to build understanding about fundamental scientific concepts through direct experience with materials, advisory books or other resources and through arguments and discussions with their peers (Tavares et al., 2015). Inquiry Learning in teaching is a multifaceted activity that includes:

- observation

- asking questions

- searching for information in books and other sources

- planning investigations

- reviewing what is already known in the light of practical tests and trials

- using tools to collect, analyze and interpret data

- formulating answers, explanations and predictions and

- discussing the results with their peers to evaluate the strengths and weaknesses of their claims.

Research shows that students who participate in an interactive learning environment show greater interest and exhibit better learning outcomes than students who are taught in the traditional teacher-centered way (Knight and Wood 2005; Salchegger et al., 2021).

The design and implementation of inquiry-based teaching and learning

The design and implementation of inquiry based teaching should be based on students' inquiry skills which become more complex depending on students' cognitive levels (Skordoulis and Stefanidou, 2021:108 -109).

In inquiry learning, students engage in asking questions, which should be focused. The question is posed either by the students themselves, or by the students with the guidance of the teacher or by the teacher. Students obtain information by observing, engaging in laboratory exercises or from the literature and then combine the information gathered to test their initial hypotheses. Students then evaluate their interpretations, engage in discussions with their peers, compare their results, and connect their results to scientific knowledge. Finally, students exchange views with their peers and identify unsubstantiated claims or consolidate their arguments for the interpretation of the phenomenon.

Teaching through inquiry helps students not only to learn about scientific processes such as observation, experimentation and inference, but also to acquire the ability to relate these processes to scientific knowledge so that they are able to interpret phenomena using logic and critical thinking. For this reason, students should be encouraged to participate in the evaluation of scientific knowledge by asking themselves, at each step of the investigative process, questions such as: "What is important and what is not important?", "What data do we keep and what data do we discard and why?", "What similarities/patterns emerge from the data?", "Are these patterns important to the outcome of the research?", "What explanations are we leading to?", "Are these explanations satisfactory?". In this way they will be able to evaluate the strengths and weaknesses of their claims (Skordoulis and Stefanidou, 2021:108 -109).

The phases of Inquiry based Teaching and Learning

In Inquiry based learning, students first begin to build their knowledge using their pre-existing ideas on the topic and then move on to explore unfamiliar areas. Students explore a limited set of fundamental and important concepts. Learning key concepts through inquiry gives students a sense of being experts rather than novices (Yang and Liu 2016).

Inquiry-based teaching and learning consists of five phases:

1. Students are involved in questions related to scientific matters.

2. Students prioritize evidence that allows them to develop and evaluate interpretations of scientific questions.

3. Students formulate evidence-based interpretations to answer scientific questions.

4. Students evaluate their interpretations considering alternative answers, especially those that reflect their understanding of science.

5. Students communicate and justify the interpretations they propose.

Guided and Open inquiry

An investigation that includes all the phases mentioned above is considered to be complete. However, the investigation may vary depending on the degree of teacher and student involvement and the topic of the investigation. Thus, the investigation can be guided, where the teacher poses the initial question and gives the students clear guidelines for the course of the investigation, or open, where the students pose the initial question and plan the course of the investigation themselves. Usually, the initial question is posed by the teacher as students have rarely developed high-level inquiry skills to be able to pose the initial question on their own (Skordoulis and Stefanidou, 2021:121). Depending on the student's degree of self-activity and the degree of support from the teacher, there are four levels of inquiry:

- Confirmatory inquiry: The teacher gives the students the initial question, clear instructions for the course of the investigation and the materials they will need. In the confirmatory investigation, the teacher has already taught the relevant unit and the investigation is used to consolidate what has been taught.

- Guided Inquiry: As in the confirmatory inquiry, the teacher gives the students the initial question, clear instructions on how to conduct the investigation and the materials they will need, except that in the guided inquiry the students have not been taught the corresponding topic before following the investigation procedures.

- Oriented Inquiry: The teacher poses the initial question to the students and the students plan their own course of investigation that will lead them to the answer of the question. The materials are either chosen by the students from a variety of provided materials or they decide for themselves which materials are needed for the investigation.

- Open Inquiry: Students ask questions and plan the course of investigation on their own. Students decide which materials will be needed or select them from a set of available materials.

3. The Three-Dimensional Model (3-D Model)

The US National Research Council (2012) proposed the three-dimensional model to improve science literacy. According to this model, teaching and learning include: the core ideas of the specific disciplines (physics, chemistry, life sciences, earth sciences), the crosscutting concepts that cut across all sciences, and the practices that correspond to them.

3.1 The Importance of Practices

Engaging students in the practices of science helps them to understand how scientific knowledge develops: their direct involvement allows them to learn about a wide range of approaches used to explore, model and explain the world. On top of this, participation in these practices helps students to understand the interdisciplinary (cross-cutting) concepts and the concepts of each scientific discipline.

Actual science practice can pique students' curiosity, pique their interest, and motivate them to further study. The information they have gained helps them to recognize that the work of scientists is a creative pursuit which has had a major impact on the world in which they live. Thus, students can recognize that they have the potential to contribute to addressing various challenges of modern society, such as energy production, preventing and treating disease, providing drinking water and food, and reducing the effects of climate change. Education, in its current form, focuses on the results of science, with little emphasis on understanding how we arrived there.

The idea of science as a set of practices emerged from the work of historians of science, philosophers and sociologists dating back more than sixty years. To conceive science as a set of practices suggests that the development of a scientific theory is an element of a larger set of activities that includes networks of participants and institutions, specific modes of oral and written discourse, the development of models for representing phenomena and systems, the development of prediction, and the testing of hypotheses through experimentation and observation.

Focusing on scientific practices avoids the mistaken impression that there is a distinct approach known to all as the scientific method. In fact, scientists use a wide range of methods. Indeed, although science includes several areas in which knowledge is still uncertain (e.g., cancer research, quantum computing, etc.), there are now so many well-established areas of scientific knowledge that we cannot deny that science is a pillar of world civilization. Only through engagement with the practices will students be able to recognize how scientific knowledge has been produced and why some scientific theories are well established, as opposed to others.

The practices of science presented to students are based on the practices that scientists follow in their everyday working lives. Obviously, students cannot reach the level of proficiency and competence of scientists. On the other hand, the opportunities offered to students to experience these practices firsthand and discover why they are important to science play an important role in their appreciation of the skills of experts and the nature of their work.

We consider eight practices as important for science education. These relate to the student's ability to:

1. Ask questions relevant to science.

2. Develop and use models.

3. Design and conduct investigations.

4. Analyze and interpret data.

5. Use mathematical and computational thinking.

6. Provide scientific explanations and design solutions.

7. Make arguments based on empirical evidence.

8. Receive, evaluate, and communicate information.

3.2. The importance of cross-cutting/interdisciplinary concepts

In this section we will refer to the concepts that cross the boundaries between disciplines and have extended explanatory power in science. These interdisciplinary (or crosscutting) concepts were selected on the basis of their presence in different disciplines of science. These concepts help students structure an organizing framework to connect their knowledge from the various disciplines, as well as to build a coherent and scientifically grounded understanding of the natural world. Although interdisciplinary concepts are important for understanding science and engineering, students are often not given an organized methodological framework for understanding these concepts.

Explicit reference to these concepts, as well as their appearance in multiple conceptual frameworks, will help students develop a coherent understanding of science. Students' ability to understand these concepts at a particular cognitive level depends on their prior experience. At present, no large-scale educational research has been conducted on the teaching and learning of these cross-cutting concepts. This is a promising area of research.

The cross-cutting/interdisciplinary concepts are:

1. *Patterns:* Observed contours of forms and events that guide organization and classification, and prompt questions about the relationships and factors that influence these patterns.

2. *Cause and Effect - Mechanism and Explanation*: Events have causes, sometimes simple, sometimes more complex. A major activity of science is to investigate and explain causal relationships, and the mechanisms by which these relationships are mediated. These mechanisms are then tested in specific contexts and used to predict and explain events in new contexts.

3. *Scale, Proportion and Quantity*: When considering phenomena, it is vital to identify different sizes and different scales of time, energy, etc., but also to understand how changes in scale, proportion or quantity affect the structure or performance of a system.

4. *Systems and Systems Models:* defining the system under study and describing the model of that system provides tools for understanding and testing ideas that apply across science.

5. *Energy and Matter: flows, cycles and conservation*: Tracking energy and matter flows to and from a system facilitates understanding of the capabilities and limitations of systems.

6. *Structure and Function:* The way an object or living organism is formed from its individual parts determines its properties and functions.

7. *Stability and Change:* For both natural and technologically engineered systems, conditions of stability and indicators of change or evolution are critical elements in their study.

The set of interdisciplinary concepts begins with two concepts of major importance to the nature of science. The first is that observed patterns can be explained, and the second is that science investigates the cause-effect relationship by seeking the mechanisms to which these relationships are subject. The next concept - scale, proportion and quantity - focuses on the size of things and the mathematical relationship between dissimilar elements. The next four concepts - systems and model systems, flow of energy and matter, structure and function, stability and change - are interrelated in a way that allows the first to be illuminated by the other three. Each concept stands out as an idea that appears in almost all areas of science. The major benefit of teaching these concepts is that students are able to identify them in different areas of science by making connections that will allow them to gain a fuller understanding of the natural world.

4. Conclusion

One of the main objectives of 21st century education is to educate students in scientific practices, the ability to engage in scientific investigations as well as to think in a scientific context. Scientific Literacy has broadened to include technology, critical thinking and analytical skills. As citizens we are required to make daily decisions on issues ranging from public health to environmental issues where Scientific Literacy is extremely important. Scientific Literacy as well as the skills developed in the science classroom will help in understanding and developing skills in Mathematics and Reading.

The three-dimensional model presented has been analyzed both in terms of its theoretical foundation and its application in a variety of educational settings, sometimes for teaching interdisciplinary concepts (Fick, 2018), sometimes for teaching social science topics (Sadler et al., 2017), and sometimes in the context of STEM education (Hoeg & Lawrence-Bencze, 2017).

Scholars have expressed their reservations regarding whether teachers are prepared to implement such a model for teaching and learning in their own classrooms (Bybee 2014; Hanuscin & Zangori 2016; Lee et al., 2014). Undoubtedly, as expected, an educational proposal coming from educational policy makers such as the National Research Council should be accompanied by an extensive teacher training programme. Moreover, we will point out that any educational reform is imperative to take into account social inequalities and social exclusions and provide the guarantees to address them, without being limited to the level of proclamations (Skordoulis and Katsiampoura, 2019:189-190). Consequently, it is up to the teacher to critique the political and economic context within which educational reforms take place and to seek their own educational and political outlets.

5. References

Baroudi S., Helder M. R. (2019). Behind the scenes: teachers' perspectives on factors affecting the implementation of inquiry-based science instruction. *Research in Science & Technological Education*. https://doi.org/10.1080/02635143.2019.1651259

Bybee, R.W. (2014). NGSS and the Next Generation of Science Teachers. *Journal of Science Teacher Education,* 25, 211–221. https://doi.org/10.1007/s10972-014-9381-4.

Duit R. & Treagust D. F. (2003). Conceptual change: A powerful framework for improving science teaching and learning. *International Journal of Science Education, 25* (6), pp. 671-688. http://dx.doi.org/10.1080/09500690305016

Fick, S. (2018). What does three–dimensional teaching and learning look like?: Examining the potential for crosscutting concepts to support the development of science knowledge. *Science Education*, 102(1), 5-35. https://doi.org/10.1002/sce.21313.

Hanuscin, D.L., Zangori, L. (2016). Developing Practical Knowledge of the *Next Generation Science Standards* in Elementary Science Teacher Education. *Journal of Science Teacher Education,* **27,** 799–818. https://doi.org/10.1007/s10972-016-9489-9.

Hoeg, D., Lawrence-Bencze, J. (2017). Values Underpinning STEM Education in the USA: An Analysis of the Next Generation Science Standards*, Science Education*, 101 (2), 278-301. https://doi.org/10.1002/sce.21260.

Knight J.K. & Wood W.B. (2005). Teaching More by Lecturing Less. *Cell Biology Education, 4, 298-310*

Lee, O., Miller, E.C., Januszyk, R. (2014). Next Generation Science Standards: All Standards, All Students. *Journal of Science Teacher Education,* **25,** 223–233 (2014). https://doi.org/10.1007/s10972-014-9379-y.

NRC (2012). A framework for K-12 science education: Practices, crosscutting concepts and core ideas. *The National Academies Press.*

Oliver M., McConney A. & McConney A. W. (2021). The Efficacy of Inquiry-Based Instruction in Science: A Comparative Analysis of Six Countries using PISA 2015. *Research in Science Education, 51* (2), pp. 595-616. doi.org/10.1007/s11165-019-09901-0

Sadler, T.D., Foulk, J.A., Friedrichsen, P.J. (2017). Evolution of a model for socioscientific issue teaching and learning. *International Journal of Education in Mathematics, Science and Technology, 5(2),* 75-87. DOI:10.18404/ijemst.55999.

Salchegger S., Paschon C. W. & Bertsch C. (2021). Explaining Waldrof students' high motivation but moderate achievement in science: Is inquiry-based science education the key? *Large-scale Assessments in Education*. doi.org/10.1186/s40536-021-00107-3.

Skordoulis, C., Katsiampoura, G. (2019). Cultural and Critical Educational Approaches to Sciences. *Education Review* 68, 178-193

Skordoulis, C., Stefanidou, C. (2021). *Didactical Methodology of Science*. Athens: Propobos

Tavares A. C., Silva S. & Bettencourt T. (2015). Advantages of Science Education Outdoors through IBSE Methodology. *Inquiry-Based Learning for Science, Technology, Engineering, and Math (Stem) Programs: A Conceptual and Practical Resource for Educators*, pp. 151-169. doi/10.1108/S2055-364120150000004010

Yang W & Liu Enshan. (2016). Development and validation of an instrument for evaluating inquiry-based tasks in science textbooks. *International Journal of Science Education, 38* (18), pp. 2688 - 2711.

Peer assessment and teachers' professional development

George Pasias, , gpasias@ppp.uoa.gr

Professor, National and Kapodistrian University of Athens

Abstract

Peer assessment is a key collaborative practice for teachers that reinforces the transformation of the school into "a learning organization and a community of learning". This paper presents "peer assessment" and its core principles as an educational 'paradigm shift', it describes its school implementation framework, which is linked to the assessment of learning processes, and it highlights its effects on teachers' professional learning and development.

Keywords : Peer assessment, teacher professional development, the school as a learning organization and a community of learning

1. Introduction

1.1. The school as a learning organization and as a community of learning

The quality of an education system cannot exceed the quality of its teachers (MacBeath, 2001). According to international studies, the effectiveness of educational reforms in a changing and increasingly complex world (knowledge societies and economies, digital world, 4th industrial revolution, risk and precarious societies) depends on the individual and collective capacity of teachers to promote new forms of learning in schools (OECD, 2005; European Commission, 2013).

The transformation of the school into a learning organization and a community of learning (SLO) is an evaluative imperative in the modern knowledge society. The SLO is a modern, distinct, alternative educational paradigm of a living, learning, evolving and continuously improving organization. The SLO constitutes a dynamic process of continuous learning, governance and transformation; it promotes changes in school structures, organization, relationships and culture and aims at the making of a new individual and collective subjectivity (Pasias, et al., 2022a). "Learning for all" is a core value for the SLO and concepts such as trust, collaboration, reciprocity, creativity and change are integrated in its policies and practices (Senge, et al. 2012, Kools& Stoll, 2016,).

In schools transforming into SLOs, teachers are organized in professional learning communities (PLCs). The 'learning community'' is made up of groups of teachers who share and critically explore their practice in an ongoing, consistent, collaborative, inclusive, learning-oriented, developmental way. They are communities of continuous inquiry and improvement that utilize collaborative learning in order to improve teachers' professional competences and learning outcomes (Harris& Jones, 2010; Marsick, et al., 2013).

1. 2. Learning Processes Assessment

'Learning' is the primary objective of the SLO and the core of its assessment rationale and strategies. It is supported by a wide range of procedures which includes systematic data collection, interpretation and utilization, evidence-based decision making and dissemination of good practices. These procedures aim at the collective learning of the organization, teacher

With the support of the Erasmus+ Programme of the European Union
CONNECT - Upskilling of sChools' teachers to effectively support ONliNe EduCaTion
KA2 - Agreement Number : 2020-1-EL01-KA226-SCH-094578

professional development, the enhancement of teachers' and students' competences and the improvement of the learning processes and outcomes (Andrade, et al, 2021, Caena & Vuorikari, 2022).

In the SLO, teachers as professionals are required to respond to a dual role concerning assessment: they are required to assess and be assessed, to act as evaluators and evaluate at the same time. In this condition, three different types of assessment coexist, complement each other and are exploited by teachers: a) assessment of learning, b) assessment for learning and c) assessment as learning (Pasias, et al., 2022b).

Current trends in education promote a gradual shift from summative assessment and *assessment of learning* towards formative types of assessment such as *assessment for learning* and *assessment as learning* (Hume, & Coll, 2009, Earl, 2013, Dann, 2014, Laveault & Allal, 2016, Yan, & Boud, 2021).

Learning Processes Assessment		
Summative Assessment	Formative Assessment	
Assessment **of** Learning	Assessment **for** Learning	Assessment **as** Learning

Source: Pasias, et al. (2022b). SLO: Communities of Learning and Peer Assessment

The transition of Learning Processes Assessment from 'summative' to 'formative' adds a distinct material and symbolic content to assessment as a philosophy, as a process, as a tool and as an educational outcome. In particular:

- The emphasis shifts from teaching to learning

- The focus is on the processes rather than the outcomes

- External teacher evaluation is transformed into internal self-assessment and learning.

In the SLO paradigm, the focus is on the transition from the level of'' learning to the level 'for' learning and to that of 'as' learning as a transformational process for the teacher and student subjectivity (Pasias, et al., 2022b).

1.3. Teacher peer assessment

Teacher peer assessment is a dynamic method of evaluation, reflection and improvement that supports the school transformation into a learning organization and a community of learning. It is directly linked to teacher professional development and individual teacher evaluation, it establishes a collaborative culture in the community, it transforms learning into a collective process and it aims at school improvement (Chism, 2007).

Peer assessment is an essential collaborative practice, it functions as a learning process for teachers and is an informal form of school-based evaluation which can be applied to all aspects of educational practice. It is usually applied in the context of teaching, but it also applies to all teacher activities. It is considered as one of the most successful techniques for improving teaching and pedagogical practices and is perceived as a supportive, open, flexible, non-bureaucratic kind of evaluation based on reciprocity, trust, self-direction and self-regulation (Pasias et al., 2015).

The pedagogical and developmental nature of peer assessment empowers peer-collaborative learning of teachers and students. The formative character of the process is exhibited in the transformation of teachers' perceptions and dispositions to improve competences, the development of new modern teaching strategies and educational practices and the formation of a much-desired culture of collaboration, collegiality and evaluation in a school ‘learning community’ (Gosling, 2014; Fletcher, 2018).

1.3.1. ‘Teacher peer assessment as a paradigm shift

Teacher peer assessment (peer review, peer evaluation) is defined as the deliberate process of observing the teaching practices of one colleague by another, providing feedback as a ‘critical friend’, as well as an expert and as a professional. Peer assessment is a collaborative high professionalism practice which enhances self-regulation and scientific communication among teachers (Tilligada Ev., 2022).

A key feature of ‘peer assessment’ is reciprocity and the sharing of knowledge, ideas and experiences between participants, so that they are eventually led to peer-to-peer learning, which is a bilateral, interactive learning activity. A prerequisite for the successful outcome of this collaborative peer practice is that there are no distinct roles between the observer and the observed, as they take turns in order to achieve the best results. Teachers are experts in their scientific and pedagogical role and thus considered as the most suitable to take the leading role concerning teaching and pedagogical practice and professional development. They know how students think and learn, as well as the specific conditions that affect the processes of learning in their schools, so they can provide constructive criticism to their colleagues, especially when the goal is to improve the quality of learning (Apostolopoulos, 2014).

The central consideration of ‘peer assessment’ is to view the school as a single collective entity and to assess the educational work produced in a holistic way, so that the focus of the evaluation process shifts from the control of performance and achievement to the interactions of the participants during the learning processes and the meanings that are formed (Pasias, et al., 2022b).

The introduction of ‘peer assessment’ in school is a key dimension of its self-evaluation processes (at both individual and collective levels). It reflects a substantial paradigm shift in the way learning at school is assessed as the focus shifts from external to internal assessment. More specifically, the following transitions are highlighted:

- from inspection that fosters fear and surveillance to forms of collective internal assessment that construct new knowledge and learning,

- from the external inspector/school counselor to the reflective - researching teacher,

- from the summative to the formative character of evaluation,

- from the culture of fear and demonization of evaluation to the culture of reciprocity, solidarity and trust among teachers,

- from defensive isolation to professional, collaborative, peer-to-peer learning,

- from pedagogical solitude to critical and reflective dialogue (Pasias, et al., 2022b).

1.3.2. Teacher Peer Assessment: the five stages of implementation

Teacher Peer Assessment is a structured and organized way for teachers to work together in order to enhance and improve teaching and pedagogical practices at school and is part of a wider culture of collaboration, mutual trust and respect among teachers.

In the SLO paradigm, Teacher Peer Assessment is not limited to an observation of teaching, but is a holistic process of transformative learning and critical reflection aimed at transforming the educational subject (individual and collective) (Pasias, et al., 2022b).

Teacher Peer Assessment effectively strengthens school learning communities by sharing good practice and enhancing their self-awareness of the impact of their own teaching in order to promote changes in educational practices and support teachers' professional development. Through peer evaluation, teachers communicate, collaborate, observe each other's practice and learn from each other. They focus on their individual needs, build on their strengths and provide constructive feedback to their colleagues while making a substantial contribution to the collective effectiveness of the school.

In the SLO paradigm, the peer assessment process is divided into five stages:

α. The stage of self-reflection

b. The stage of preparation for the classroom observation

c. The classroom observation stage

d. The feedback stage

e. The stage of critical reflection (Pasias, et al., 2022b).

Teachers Peer Assessment: The implementation process				
The stage of self-reflection	**The classroom observation process**			**The stage of critical reflection**
Self-reflection -------- **Self-awareness** ------------------------ - SWOT Analysis	The stage of preparation for the classroom observation ----------- Pre-teaching meeting	The stage of the classroom observation ------------------- -	The post-observation stage ----------------------	**Critical reflection** **----------** **Self- efficacy**

Learning walk Classroom/ Study visit Study of relevant literature Choice of a colleague	Purpose, objectives, means, procedures	Teaching observation	**The feedback process**	**Self-regulation**

Source: Pasias, et al. (2022b). SLO : Communities of Learning and Peer Evaluation

1.4. Professional learning and teacher development

Enhancing teachers' professional learning and development is a cutting-edge area of current education policies. Current trends in teacher education and training are linked to a shift towards a student competence-centered model. Teachers are required to focus not only on improving learning outcomes, but also on cultivating and developing an expanded and holistic framework of student competencies (knowledge, metacognitive skills, attitudes and behavior) (Caena, 2011).

Improving the quality of the teaching profession is linked to the development of a ‘qualification framework’ for teachers that involves the renewal and expansion of knowledge, attitudes, values and professional skills. Particular emphasis is placed on the development of 'professional' competences, which include metacognitive skills, critical analytical thinking, problem solving, autonomy, self-evaluation, reflection, commitment, initiative, communication, teamwork skills, creativity and a positive attitude towards research, innovation and change (European Commission (2013).

Teachers’ reflective and collaborative skills as components of ‘transformative learning’ are key parameters in the formation of school ‘learning communities’ and are perceived as both a prerequisite for successful implementation and as an outcome of change in the learning processes (Mezirow, 1991; Brookfield, 2005).

Implementing self-evaluation and ‘peer assessment’ processes lead to particular changes in teachers’ personal theory. Effective engagement of teachers in the collaborative practice of ‘peer assessment’ requires the teacher to be able:

- to challenge personal beliefs, habits, practices,

- to deconstruct their own educational profile,

- to eliminate/decrease his/her isolation,

- to be ‘open’ to new knowledge, new experiences and practices,

- to develop a culture of (self-)evaluation,

- to be able to make constructive criticism of his/her colleagues' practices (Pasias, et al. 2022).

Teachers' reflection is considered as an important catalyst for the transformation of everyday work/experience into individual and group organizational knowledge and professional learning. Fruitful reflection is considered to be critical reflection that goes beyond the level of mere observation and examination and leads to questioning and rejection of established assumptions and critical analysis of experiences (Hattie & Timperley, 2007).

Critical reflection confronts the teacher with complex processes, challenges, choices, in terms of choosing and implementing appropriate teaching-pedagogical methods adapted to the specificities of students, and even requires an immediacy, readiness and a level of pedagogical and professional maturation in order for conscious and direct action. At the same time, it is a means of 'self-understanding', of recognizing the knowledge, values and perceptions of each teacher, as well as a means of controlling and promoting personal development. It represents a process of self-awareness and self-assessment through which teachers understand, interpret and improve their professional learning and educational practices, contributing substantially to the transformation of themselves, their students and the school (Tilgada Ev., 2022).

1.5. Benefits of "Teacher Peer Assessment" for teachers and the school

Research results from the implementation of peer assessment in schools show that it contributes positively to professional development and to important dimensions of teachers' work, such as the reduction of teachers' privacy and isolation, the improvement of collaboration, the dissemination of effective teaching practices and the enhancement of teachers' self-confidence (Pasias, et al., 2014).

Peer evaluation provides opportunities for teachers to examine and reflect on their teaching, pursue self-improvement, and implement teaching practices that support and enhance learning outcomes. Teachers enhance their self-image, tend to trust themselves more, and cultivate the reflective practitioner who collaborates, researches, shares and exchanges views and thoughts to improve skills and practices. The teacher pursues professional learning, supports new knowledge, innovation and change, promotes values such as democracy, collegiality and solidarity in the school setting (Samara &Tiligada, 2021).

At the collective level, 'peer assessment' is a collaborative practice that improves the quality of the school and contributes significantly to its transformation into a professional learning community. The development of 'peer assessment' in schools establishes the rationale of research and reflection, consolidates scientific understanding and interpretation of the school reality and strengthens teachers' commitment to effective professional development. It also highlights the value and necessity of school-based training and creates opportunities for the dissemination of knowledge and good practices to the wider educational community.

2. References

Andrade,H.,Brookhart,S. & Yu (2021). "Classroom Assessment as Co-Regulated Learning: A Systematic Review", *Frontiers in Education*, vol.6, pp.1-18.

Apostolopoulos, K. (2014). "The evaluation of teaching by teachers and students. A professional development process for teachers in the context of school self-evaluation". *Erkyna, Review of Educational Science* , (1) , pp. 25-51.[in greek]

Brookfield, S. (2005). *The Power of Critical Theory for Adult Learning and Teaching*. UK: Open University Press.

Caena, F. (2011). *Literature review. Teachers' core competencies: Requirements and development*. Brussels, Belgium: European Commission.

Caena, F. & Vuorikari, R. (2022). Teacher learning and innovative professional development through the lens of the Personal, Social and Learning to Learn European key competence, *European Journal of Teacher Education*, 45(4), pp.456-475.

Chism, N. (2007). *Peer review of teaching: A sourcebook* (2nd ed.). Bolton, MA: Anker

Dann, R. (2014). "Assessment as learning: blurring the boundaries of assessment and learning for theory, policy and practice". Assessment in Education: Principles, Policy & Practice, 21(2), pp. 149-166.

Earl, L. (2013). Assessment as Learning: Using Classroom Assessment to Maximize Student Learning. 2nd ed. Thousand Oaks, CA: Corwin.

European Commission (2013). *Supporting teacher competence development for better learning outcomes*, July 2013, Brussels : Education and Training.

Fletcher, J. (2018). "Peer Observation of Teaching: A Practical Tool in Higher Education". *The Journal of Faculty Development*, pp.51-63.

Gosling, D. (2014). "Collaborative Peer-Supported Review of Teaching". Στο J. Sachs, & M. Parsell, *Peer Review of Learning and Teaching in Higher Education. International Perspectives*, Springer, pp. 13-31.

Harris, A. & Jones, M. (2010). Professional learning communities and system improvement. *Improving Schools*, 13 (2), pp. 172-181.

Hattie, J. & Timperley, H. (2007). The Power of Feedback, Review of Educational Research, 77 (1), pp. 81-112

Hume, A. & Coll, R. (2009). "Assessment of learning, for learning, and as learning: New Zealand case studies", *Assessment in Education: Principles, Policy & Practice*,16(3),pp.269-290.

Kools, M. & Stoll, L, (2016). "What makes a school a learning organization?", OECD Education Working Papers, No. 137, Paris: OECD.

Laveault, DAllal, L. (eds.) (2016). *Assessment for learning: Meeting the challenge of implementation*, Springer International Publishing.

MacBeath, J. (2001). S*chools Must Speak for Themselves. The Case for School Self-Evaluation*, London: Routledge.

Marsick, V. J., Watkins, K. E.& Boswell, S. A. (2013). Schools as Learning Communities. In R. Huang et al. (eds). *Reshaping Learning New Frontiers of Educational Research*. Berlin – Heidelberg: Springer-Verlag, pp. 71-88.

Mezirow, J. (1991). Transformative Dimensions of Adult Learning. San Fransisco: Jossey-Bass.

OECD (2005). *Teachers Matter. Attracting, Developing and retaining effective teachers* (Overview). Paris: OECD.

Pasias, G., Apostolopoulos , K., & Styliaris, E. (2014). Peer assessment: evidence from its pilot implementation in Protypa Peiramatika Schools in the school year 2013-14. Proceedings of the 1st D.E.P.P.S. Conference (26 -28/9/2014). Athens. [in greek].

Pasias G., Apostolopoulos, K., & Styliaris, E. (2015). "Self-evaluation"" and "Peer assessment": processes for school improvement and transformation into a professional learning community". *Erkyna, Review of Educational-Scientific Issues*, (7), pp.25-35. [in Greek].

Pasias, G., Samara, A., Stratou, H. & Tiligada, E. (2022a). The School as Learning Organisation : Learning Communities & Peer Assessment, Vol. I: Theoretical Framework, Department of Secondary Education, NKUA, November 2022. [in greek]

Pasias, G., Samara, A., Stratou, H. & Tiligada, E. (2022a). The School as Learning Organisation : Learning Communities & Peer Assessment, Vol. II*:* Framework and Implementation Processes, Department of Secondary Education, NKUA, November 2022. [in Greek].

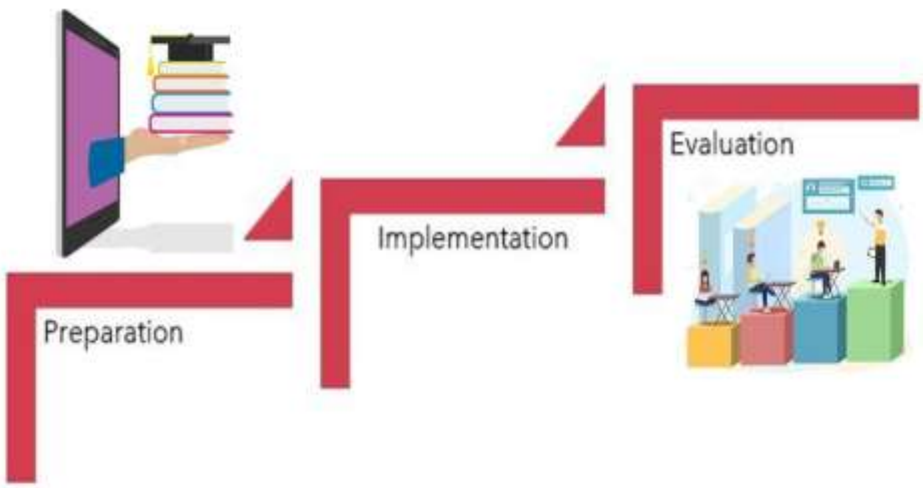
Samara, A. & Tiligada, E. (2021). "Professional learning communities and teachers' continuous professional co-development". Proceedings of the 7th IACC International Scientific Conference, Social Vulnerability and Development. Challenges in education, economy and culture, Heraklion, Crete, Greece, pp. 107-114. [in Greek].

SengeP., etal. (2012). *Schools That Learn. A Fifth Discipline Fieldbook*. London: Nicholas Brealey Publishing.

Tiligada Ev. (2022). *Collaboration and professional development of teachers in the learning community*. Doctoral dissertation, School of Philosophy, Department of Secondary Education, NKUA. [in greek].

Yan, Z., &Boud, D. (2021). "Conceptualising assessment-as-learning". In Z. Yan, & L. Yang (eds.), Assessment as learning: Maximizing opportunities for student learning and achievement (pp. 11-24). New York: Routledge.

PILOTING



Piloting

A. Objectives and Benefits

Objectives

. Upskilling teachers to implement innovative educational practices, such as the flipped classroom.

. Enhancing teachers' ability to develop educational scenarios based on innovative practices such as the flipped classroom based on proper digital interaction.

. Increasing collaboration among teachers at the school level.

. Improving the learning process (fostering active participation, interactive interaction).

Benefits

1. Familiarization with innovative practices such as the flipped classroom.

2. Learning to develop educational scenarios based on innovative practices.

3. Increasing collaboration among teachers at the school level.

6. Teacher's self- improvement and professional development.

7. Upskilling teachers

8. Improving the learning process.

B. Phases

Phase 1 (Preparation):

- Study the supportive material on MOOC and on project's website
- Fill out the initial data and pre-test questionnaires (for teachers and students) (Google Form)
- Find peer-reviewers (educators who will evaluate your scenario before being implemented or during implementation)
- Find coordinators or supervisors
- Create communities of practice

Phase 2 (Implementation):

- Implement the Scenario
- Fill out the post-test questionnaires (for teachers and students)
- Complete the reflection diary
- Fill out the "Good practice" Template (1 practice per course)
- Complete a final report in the context of which the entire experience on piloting should be presented (Complete the final report template).

* Do not forget to take photos, capturing significant moments of piloting

Phase 3 (Evaluation):

Coordinators or supervisors will take on the responsibility to collect the requisite data and send the respective data set to the University of Cyprus to analyze the data across courses and across schools with a view to providing feedback on the entire pilot reverberation.

C. Keynotes of Piloting

1. The scenario should be based on the Flipped Classroom Approach (before class, in class and after class)

2. In case you modify an existing scenario or develop a new one you will have to describe the changes in detail in the reflection diary or in the final report.

3. Coordinators or supervisors will take on the responsibility to monitor the entire piloting and to care for the data collection process.

4. The scenario should be tailored to the needs of the curriculum (for Maths, Physics and Foreign Language).

5. The “good” practice template should be filled out after the piloting, indicating good practices in terms of Mathematics, Physics and Foreign Language. One good practice per teacher and per course is needed.

6. The general objective of piloting is to foster collaboration among students, between students and teachers and among teachers.

D. Indicating Good Practices

The cardinal objective of piloting is to indicate good practices that could be employed to promote active learning in the context of the “CONNECT” approach. The template sheds light on the way significant information in relation to good practices could be elicited:

GOOD PRACTICE TEMPLATE

Country	
School Name	
School Address	
Teacher's Name & Surname	
Teacher's Specialty	
Course	
Didactic Unit	
Class/Grade	
Short Description	
Learning Objectives	

Instructional Method	
Digital Resources	
Goals' Achievement (Results)	
Why to call it a Good Practice?	

E. Assessing the entire venture

A final report template has been developed to contribute to the collection of the requisite data that could be analyzed in order to get feedback on the pilot reverberation at teachers and at students. The analysis of the respective data set could provide feedback on the pilot's goals' achievement:

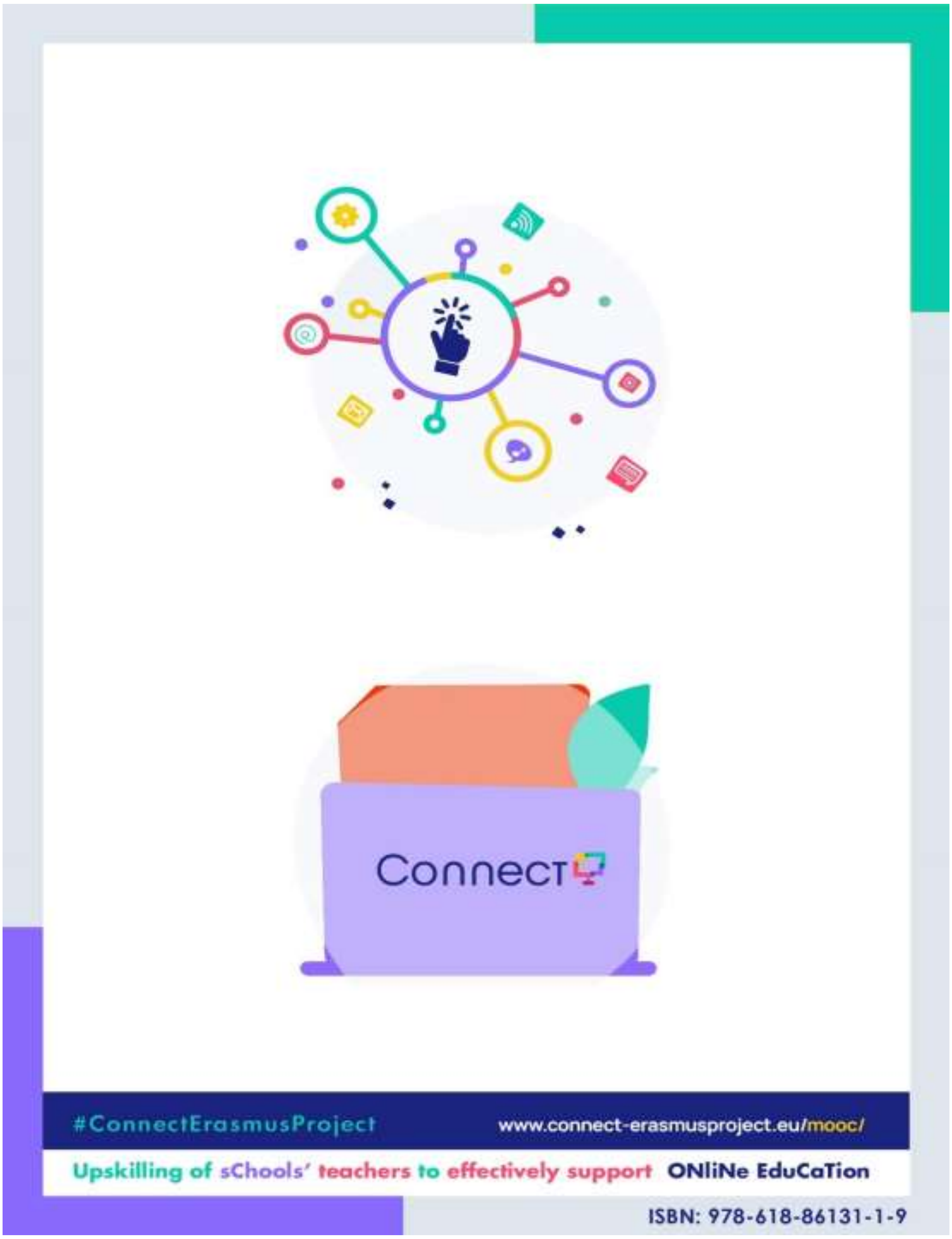
FINAL REPORT TEMPLATE

Country	
School Name	
School Address	
City Background (School's location)	**Citizens' Financial Status, Cultural state, Geographical features (geographical terrain)**
Total Number of Students Attending (Divided by Gender)	
Number of Students attending (per course) (Divided by Gender)	
Supervisor's Name and Surname	
Average Students' Age (per course)	
Highlighting the reverberation of piloting at students (per course) - **Fostering collaboration** - **Fostering participation** - **Developing skills**	

Highlighting the reverberation of piloting at teachers (per course) - **Fostering collaboration** - **Enhancing their teaching approach** - **Upskilling and Professional Development**	
Indicating Lessons Learnt from piloting (per course) - **Instructional Shift** - **Need for developing collaborative skills** - **Changes of roles**	
Indicating Good Practices drawn from piloting (per course) - **Total number of Good Practices** - **Keynotes of Indicative Good Practices**	
Assessing the peer-review process and the communities of practice - **Contributing to the pilot implementation** - **Contributing to ameliorating the learning process** - **Contributing to professional development**	

- Contributing to overcoming difficulties - Contributing to understanding the “CONNECT” approach	
Assessing the entire piloting - Regarding the pilot objectives - Regarding the “CONNECT” approach objectives (upskilling)	
Describe a memorable moment that marked the entire piloting - A memorable comment - A significant moment - An important feeling - A critical didactic incident	

Pilot improvement - **Regarding planning** - **Regarding implementation** - **Regarding Evaluation**	


Connect
#ConnectErasmusProject
www.connect-erasmusproject.eu/mooc/
Upskilling of sChools' teachers to effectively support ONliNe EduCaTion
ISBN: 978-618-86131-1-9