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Editorial message

Dear Colleagues,

It is with pleasure to announce the new issue of the **Journal of Integrated Information Management (JIIM)** publication. **JIIM** is an international, multidisciplinary, blind peer-reviewed journal that publishes research efforts on all aspects and issues regarding Information Science and Integrated Information Management.

Expressing our commitment to promoting high-grade quality scientific papers, we present you with the current issue, which contains four new articles.

The first paper presents, compares and discusses past and recent survey findings regarding the opinions of Archival, Library and Information Studied (ALIS) Department undergraduate, postgraduates' students and faculty members about the use of ALIS eClass. One of the most interesting results of this study is the fact that recently registered members tend to use eClass more. The study concludes that the strategic goal of the ALIS Dept to use the eClass as a centralized structural component for the educational process in the Department, is a successful and sophisticated choice.

The following paper presents a comparative automated text classification process, between DEVMAX.DF, a tool proposed by the authors and the classic TF.IDF, aiming to provide an accurate automated classification tool as an alternative to manual assignments. Text classification, that mainly concerns the selection of the most important term-words for document representation, was conducted by applying 14 classifiers available on WEKA, in 718 abstracts of the digital library of the University of Western Attica, Hypatia. Classification process yielded an excellent ~97% precision score and DEVMAX.DF proved to perform better than classic TF.IDF.

Embracing the multidisciplinary spectrum of the Information realm, which also includes physical preservation of valuable material, in the next paper, experts in this field will be informed of an important investigation on the artificial ageing of paper. This work reports that accelerated ageing of pure cellulose paper in sealed vessels results in an overall deterioration of important paper properties and that the evolution of pure cellulose paper properties can be modeled efficiently by using the equations presented in this paper.

The last paper discusses a holistic, user-driven approach for the development of an innovative, open-access Educational Framework that includes six emerging information-related literacies: Critical Literacy focusing on inequalities, Digital Literacy, Mobile Literacy, Data Literacy, Media and Information Literacy and Sustainable Development Literacy. The Educational Framework of these literacies is based on the structural support offered by the various Information Literacy models and is addressed to educators and librarians. The proposed Educational Framework is a conceptually, strategically, technologically and educationally pioneering endeavor in answering specific urgent demands of the current Information and Knowledge Society.

We are aiming at making JIIM a reputable scientific communication channel, and we are now welcoming submissions for the upcoming journal issues as well as proposals for Special Issues. Your proposal should be no more than five pages and include at least an executive summary, a proper justification why the Special Issue is needed and how it is suitable with the JIIM topics. Special Issues proposals should be sent directly via email the Assistant Editor-in-chief (dkouis@uniwa.gr).

Finally, we expect your contribution and active support with remarks and points of improvement.

Assistant Professor - Assistant Editor-in-chief
Dimitrios Kouis

Department of Archival, Library and Information Studies University of West Attica Agiou Spyridonos Str., 12243 Aegaleo, Athens, Greece

Evaluation of the Archival, Library and Information Studies Department eClass at University of West Attica

Alexandros Koulouris
Department of Archival, Library & Information Studies, University of West Attica, Athens, Greece
akoul@uniwa.gr [**ORCID:** 0000-0002-4011-2678]

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Abstract:

Purpose *- This paper presents and discusses the main results of a survey concerning students and faculty (academic staff) evaluation of the eClass of the Department of Archival, Library & Information Studies, University of West Attica, with the use of online questionnaire. The survey was conducted in October 2019 and it is a comparative study of a previous research-survey (about the eClass) of 2012.*

Design/methodology/approach *- The questionnaire, consisted of open and closed-ended questions, and were sent respectively to the undergraduate and postgraduate students and the faculty's staff (or professors) of the Department. As a result, 275 valid answers (233 undergraduates and 42 postgraduates' valid responses) translated to a net response rate of 39%, while the faculty survey returned 29 valid answers with a 100% participation rate.*

Findings *- The findings demonstrate that the students and the faculty agree that the eClass is essential for the Department's courses and program (undergraduate and postgraduate). The communication and the interactions between the eClass platform and the users (faculty and students) has been very well established. Finally, the more interesting result that revealed from the regression analysis that was conducted, is that the more recent registration by the users (student and faculty), the more they visit the platform (eClass) and the higher they appreciated the system's functionalities aspect.*

Originality/value *– Useful findings were extracted regarding the evaluation of ALIS Dept eClass, after (almost) ten years of implementation. Useful comparison was made with the previous evaluation in 2012 and joined results extracted. The opinions gathered from the undergraduate and postgraduates' students, and the faculty, reveal that the strategic goal of the ALIS Dept to use the eClass as a centralized component for the studies in the Dept, is a sophisticated choice.*

Index Terms **— eClass, e-class, moodle, evaluation, teaching, distance learning, e-learning, surveys, limesurvey, higher education, users' access policy, information policy, information management, students, faculty.**

I. INTRODUCTION

Information and communication technology (ICT), a game changer for the education sector **[1]** has shifted over the last few years educational practice from a closed, teacher-controlled pedagogical approach to an open, transparent, integrated society that supports the student's initiative, facilitating collaboration, personal skills, and lifelong learning.

This technology supported smart learning environment enriched with digital resources, context-aware and adaptive devices, and can provide appropriate support to meet the learning style and abilities of diverse students **[2]** marking a clear convergence between Knowledge Management strategy and technology **[3]** is putting the student at the heart of a new training paradigm **[4]**. In order to address their expectations and perspectives built around multidimensional and interactive media sources, educational innovators under the pressing need for convincing learning scenarios and designs **[5]** and the implementation of alternative learning strategies **[6]** have started to establish the VLEs as fixtures of the higher education landscape **[7];** and teachers as coordinators and organizers of independent, informative activities **[5]**.

According to several studies, delivering information via the web is gaining popularity among both students and staff and LMS (*Learning Management Systems*) are currently supporting an entire university's teaching and learning programs providing many benefits including an increased accessibility to information, better content delivery, personalized instruction, content standardization, accountability, on-demand availability, self-pacing, interactivity, confidence, and increased convenience **[5], [8], [9]**. They have already become the default starting point of technology-enabled learning **[10]**, in Cavus **[11]** offering integrated support over the six different dimensions of creation, organization, delivery, communication, collaboration and assessment **[12]**.

The implementation of this nevertheless complex environment usually referred to as learning platform, course management system, content management system, e-learning portal, or instructional management system **[13]** requires

- The development of new skills and sets of pedagogies **[14], [15], [16], [17]**
- The reconsideration of the format and effectiveness of student assessment **[17]**
- The reevaluation of the importance of teaching styles, student motivation, infrastructure reliability and university support **[18]**
- The role of instructor confidence and imagination to encouraging the students to participate in e-leaning or blended learning activities **[19]**
- The evaluation of the impact of institutional ethos, culture structure and administration **[20], [21]**
- The rethinking of all the cognitive and behavioral components as well as social factors that potentially affect stakeholders buy-in and long-term benefits **[22], [23], [21]**

The Department of Archival, Library and Information Studies (ALIS), based at the University of West Attica (UNIWA) (formerly known as Technological Educational Institute of Athens abbreviated *TEI of Athens*) is using a Moodle installation as its eClass platform from 2010. Moodle is a freely distributed open source software, and has been one of the most popular Course Management Systems (CMS). The faculty (professors) has invested a significant amount of time and effort and has created more than 50 online courses in undergraduate, postgraduate (master), PhD and Erasmus level, which provide students with all the necessary course material (multiple bibliographies, presentations, e-books and other text and multimedia resources). The online resources also include activity modules, assignments and quizzes that utilize the interactive and collaborative environment of Moodle.

This paper, is a study which presents the evaluation of the department's eClass in October 2019, which has been based on an online questionnaire, part of it addressed to the faculty and part of it to the students. The questionnaire attempted to collect data concerning the users' attitudes and profiles (visiting frequency, favorite activities) and their opinions about the functionality and usefulness of the eClass in enhancing the teaching and learning experience. The results fully confirm the faculty's view that the eClass is an indispensable addition to the departments teaching tools and demonstrate that it is extensively used and highly appreciated by both faculty and students. The results of the current study (in 2019), are compared with the results of a previous study that evaluated the eClass and was conducted in 2012 by Zervos et al. **[24]**.

After (almost) ten years of using eClass (and Moodle) in ALIS Dept, a current and further research was necessary (according to author's opinion) to reveal the evolvement and the experience of the eClass use among the students and faculty (professors).

II. LITERATURE REVIEW

The literature review, it examines the learning management systems (LMS), and especially Moodle, which is used in *ALIS* (*UNIWA*).

LMS Research

The corpus of literature dedicated to understanding how the use of Course Management Systems (CMS), Web-Based Course Environment (WBCE), Virtual Learning Environments (VLES) or Learning Management Systems (LMS) **[25],** impacts on pedagogical practices in higher education. Beetham & Sharpe [7], and Holmes & Prieto-Rodriguez (2018) **[26]**, believe that this is still under development and according to Sánchez et al. **[27]**, and Duygu et al. [9], there still is a dearth of research regarding the factors that influence students and staff's acceptance of LMS.

The very little evaluation, if any, carried out on the use of the system or what impact it may be having on learning and teaching on the one hand and criticism for its instructor-centric nature and limited impact on pedagogy on the other **[28]** have contributed to the meagre use of the LMS to a large extent.

As a result, universities confronted with these challenges have being modifying and blending its capabilities with more traditional methods and new technological tools **[29]**.

Despite the fact that many experts within the higher education sector herald LMS and information and communication technology (ICT) in general to add new dimensions of richness and complexity to the student learning experience and promising results are already being reported on the international record, there are voices warning that many of these technology-based systems are never used to their full potential [28], [8].

The blended learning construct that has attracted much attention within the higher education sector in recent times, an evolving phenomenon in higher education that has been debated about its definition, purpose and impact **[30]**, **[28]**, **[31]**, is a solution by combining several different delivery methods, such as collaboration software, Web-based courses, and knowledge management practices, maximizes its effectiveness **[32]**.

Higher Education administrations are taking into consideration LMS's implementation obstacles such as cultural problems and conventional mindsets, literacy problems on the usage of CMS, from both sides (faculty and students). The availability of funding as identified by Saputra et al. **[33]** consider ''expedient to apply a mixed training model combining the elements of distance education with the traditional learning process in different proportions'' also commonly referred to as web-enhancement **[34]**, **[35]**, especially in the case of Greece Technological Educational Institutes that only recently upgraded their roles and functions in the higher education (HE) realm.

The Greek higher education blended learning model oscillating between, according to Graham's taxonomy **[14],** «Face-to-Face Driver» model, where electronic training is

used as addition to the main program and the «Rotation». model where school hours are distributed between individual electronic training and training in class together with the teacher. The teacher is working on-site in class also carries out remote support at electronic training. The teacher has the freedom to organize course resources in multiple ways for various classes. An acute lack of standardization is however gaining traction within student populations according to the study by Kyrgios **[36]**, where the majority (74,5%) of students were in favor of a combination of traditional and online course and content delivery that is blended learning.

Although the official LMS in most Greek universities is Open eClass, there are many institutions that judged the flexibility of Moodle most suitable for the multimodal delivery approach in their attempt to involve the strengths of each type of learning environment and none of the weaknesses [28].

Moodle Advantages

The fact that Moodle is open source and is configured around social constructionist pedagogy combining aspects of constructivism (knowledge is generated through mediation and interaction with the environment) and constructionism (learning by doing) **[27]** was the basis of the rationale for its adoption by a large number of institutions between 2003 and 2012 **[7]**.

According to Walker et al. **[37]** "Moodle is a fine example of how and why open source works". Developed by Martin Dougiamas and headquartered in Perth, Australia, and first released in 2002 it has since grown both in its robust, cutting-edge feature set **[6]** challenging traditional preconceptions and fears concerning core OSS adoption **[37]** by enabling among others interaction, customization, social presence and a sense of community **[25]**.

The Community Perspectives

Studies by Xu and Mahenthiran **[17]**, Zervos et al. **[24]**, Gower and Barr **[26]** and Santamaria, Ramos and Antolin **[27]** reveal a student appreciation of the eClass usefulness, user friendliness, navigational and system quality aspects. Palmer & Holt **[38]**, and Holmes and Prieto-Rodriguez in 2018 **[26]**, claim that there is evidence that students generally have a more positive view of the platform than staff while they also seem more positive towards the accessibility of course resources afforded by LMS and student to student interactivity features **[26]**. Their perceptions around procedural efficiencies, such as assignment submission and access to gradebooks, is equally positive according to Mestan **[39]**.

On the contrary, students had expressed dissatisfaction with support and communications, instructor quality and the lack of content and course layout standardized approach **[40]**. In detail, students were more concerned with the quality of the online teaching, which was reflected in their perception that their teachers were neither engaged enough with them in what they believed ought to have been an interactive learning environment nor spent enough time using the platform. They were also dissatisfied with poorly designed and maintained sites rather than the lack of a site **[41]**, **[35]**. Among their most common concerns were those related to the inability to interact with the faculty and inability to seek help if it is needed **[34]**.

Teachers overestimate slightly the educational impact of all the activities as compared to students **[24]** while seem more concerned with technical aspects and workload issues **[41]**. They ask for more support in using the software **[24]** and agree with the suggestion that some kind of standardization would be useful for students **[40]**. One of the problems identified by the teachers regarding the use of Moodle is the lack of training in using Moodle **[27]**. Fidalgo et al. **[23]**, found that staff were generally less positive about the interactive features of LMS than students. Finally, the results showed that most teachers, by a narrow margin, had not changed their pedagogical practice as a consequence of using Moodle **[23]**.

Overall, international research repeatedly reports faculty and student fewer positive comments about the frequency of the use of the platform's interactive aspects that apart from quizzes and discussion boards are considered underutilize. Results suggest that Moodle despite its great potential, is mainly used as a repository for exchanging files and a platform to publicize assessment without nevertheless incorporating elements of feedback **[12]**, **[25]**, **[13]**. According to Morgan **[42]** and Malikowski et al. [43], the most-used functional features are document downloads, asynchronous communications, quizzes, drop box and gradebooks/class management.

Moodle Research

Numerous studies from developed countries during the last decade analyze the effectiveness of Moodle as a b-learning tool in higher education. Escobar-Rodriguez and Mongo-Lozano **[22]**, Martín-Blas and Serrano-Fernández **[44]**, and Damnjanovic et al. **[21]**, report improvements in the learning process, higher motivation and higher student retention.

After years of use of the asynchronous University eLearning platform at the Department of Archival, Library & Information Studies of the University of West Attica (former Technological Educational Institute of Athens), the administration was urged to search for an alternative due to content and funding issues. Although higher education institutions are usually known for their reluctance towards change and empirical research on Moodle is relatively small in number according to Chunlin **[13]**, its adoption had been validated in 2010 based on educational and operational criteria that indicated Moodle (the current eClass installation in the ALIS Dept) as the most viable solution **[24]** offering a plethora of configured modules and external tools ranging from assignments, workshops, chats, forums and quizzes to blogs, questionnaires and wikis **[13]**.

III. AIMS AND OBJECTIVES

The incorporation of LMS into higher education institutions is a complex process. As the number of universities that enter the domain increases, considerations in the international research record today keep mounting.

- The mismatch between the potential of technologies and the actual use that on the one hand questions the return on the e-learning investment **[28]** while on the other seeks to mitigate the resistance to e-learning by faculty members worldwide partly due to their perceptions of the limitations of e-learning and the insufficient maturity of the available tools and the lack of time or motivation to carry out what is basically an additional task **[35]**.
- Issues caused by and resulting in the inappropriate translation of traditional delivery models into the digital realm can make an online library presence clumsy and boring **[45]**.
- The exploration of correlations between perceived usefulness, behavior intention to use the system, satisfaction, and instructor's attitude toward and control of the technology, instructor's teaching style, student motivation and technical competency, student–student interaction, course content and structure, ease of Internet access, infrastructure reliability and university support **[46]**.
- E-assessment and the importance of alternative assessment methods that aim to improve higher-order thinking skills and educational objectives (i.e., deeper understanding of the material through the active use of the knowledge in more realistic and complex contexts) **[47]**.
- The extent to which academic library's presence in LMS is desirable or necessary so that it strengthens its relevance to students and faculty **[1]**.

Indeed, university leaders are required to investigate several plans and parameters to insure the successful adoption of LMS. Despite the increasing use of smart learning environment in higher education, there is no well-defined model with a set of educational requirements for developing and evaluating it **[2]**. Notwithstanding, several models have been proposed and tested over the years including the Technology Acceptance Model (TAM), one of the most widely used and validated models for investigating the adoption of new technologies. Although of limited application in the education realm **[28]**, its extended version with the integration of other external variables such as Computer Self-efficacy, System Quality, Information Quality and Technical Support or even the combination of the Diffusion of Innovation Theory (DIT) and TAM **[48]** and the model proposed by Duygu et al. **[9]** based on the belief factors of the technology acceptance model; namely perceived usefulness, perceived ease-of-use and external factors including self-efficacy, enjoyment, subjective norm, satisfaction, and interactivity and control.

Under the influence of the general requirements defined by the "Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG)", adopted at the Bergen Summit (2005) and subsequently presented at the Erevan Summit, covering dimensions that are vital to the quality in higher education through the definition of a common framework for quality assurance systems in terms of learning and teaching at European, national and institutional levels **[4]**. In the absence of a Good Practice Guide, at the example of universities in countries that have developed distance learning or blended-education courses or the lack of a LMS evaluation standardization method education, decision makers are taking into consideration the challenges associated with quality assurance systems in a blended learning HE context due to the conflict between quality for accountability and quality of teaching due to the perceptions of different stakeholders. As a result, they are encouraging research and experimentation to help understand the role of LMS in higher education in general and the development of innovative monitoring and tailor-made evaluation practices to:

1. detect whether there is a mismatch between the potential of technologies and actual use begs the question of how to return on investment, given one of the major rationales for such an investment is to maximize the quality of the student learning experience and outcomes **[28]**
2. assess the quality of the e-learning system implementation
3. identify focal points when providing professional development to faculty
4. identify main barriers to e-learning effective implementation
5. measure how well the system delivers on key functions and supports the online learning environment to serve the academic mission
6. check if the platform's potential is fully developed and to know what is the relative maturity use of this technology at the university

Within this realm and given the fact that the ALIS Dept relies heavily on the use of the eClass, a survey was developed as part of the formal evaluation cycle that sought on a regular basis to measure the impact on the learning procedure. The extent of both faculty and student utilization of the various learning activities and features should be dully measured and evaluated [24] and subsequently, by verifying changes in performance and attendance, set the foundation for a more organized effort.

This descriptive exploratory study following a positivist approach aimed to obtain first-hand inputs of the real eClass use in the Department. Items were adapted from the prior study of 2012 which was based on the existing literature with modifications; however, in 2019 the expanded and new research was aimed to meet the current research objectives and the department's organizational goals. The questionnaire tool was Lime Survey. The survey instrument

investigating the collaborative, individual and instructor-led Moodle dimensions targeted the collection of input around both the social cognitive and information system success variables. For that purpose, it was composed of three sections. In the first section, the participants were asked to provide information related to study program, program admission year and preferred mode of access to eClass.

In more detail, in the second section the participants were asked to provide information related to the frequency regarding the usage of the e-learning services and their favorite components of the Moodle platform. The last section of the questionnaire, sought a characterization of the use of Moodle, the degree of importance assigned to the use of each tool and the educational impacts of the platform use over several dimensions asking participants to rate their overall experience in terms of ease of use and usefulness.

The completed student survey returned 275 valid answers (233 undergraduates and 42 postgraduates' valid responses) translated to a net response rate of 39%, while the faculty (professors) survey returned 29 valid answers with a 100% participation rate. Only complete questionnaire results will be reported and analyzed.

IV. Discussion and Findings

The surveys comprises of quantitative and qualitative items seeking student perceptions of features that need to be implemented to extend eClass as a learning tool.

It seems there is a decrease in the eClass visiting frequency on the student side between years 2012 and 2019 as the percentage of student access on a daily basis has dropped about 10%; while the slight increase of access to the platform on a weekly basis (3,5%) cannot compensate for the reduced traffic. On the other hand, the observed upward trend in the time that students interact with the system (increase of 23% for visit duration averages between 1 and more than 10 hours) accompanied by a decrease in the number of students that visit Moodle for less than 1 hour sends out a positive message in terms of the platform's effectiveness in keeping students engaged (figure 1). *The figures indicate the year 2020 (instead of 2019), because the survey was conducted in October 2019, however, it has data from the academic year 2019-2020.*

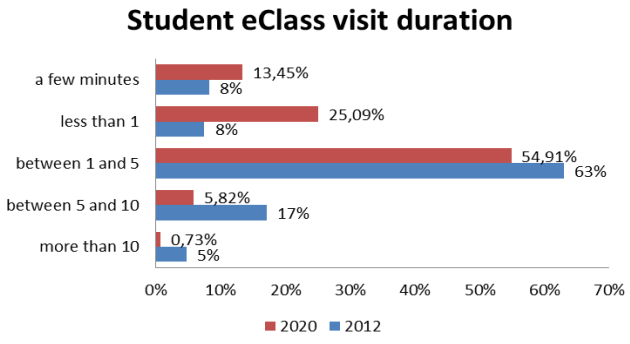

Figure 1. Students eClass visit duration

As to most frequented student activities recorded in the two surveys, figures regarding communications, quizzes and glossaries do not reveal any significant changes and still remain low, while the slight decrease in material downloads, lab registration and other procedural activities in combination to the 1% increase in using the LMS to keep up with latest news on educational and community topics raises a red caution flag to the emergent necessity of coming up with new strategies to increase the platform's attractiveness among the Department's stakeholders (figure 2).

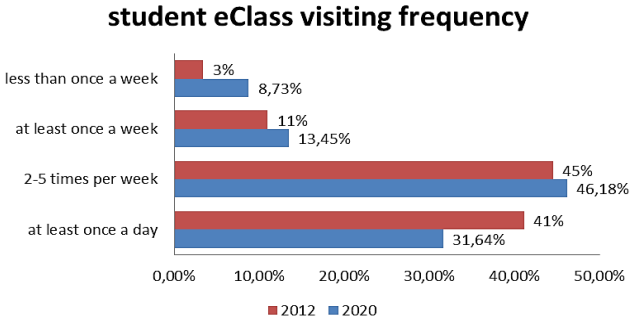

Figure 2. Students eClass visiting frequency

The participants' verbatim comments are revelatory of the current situation, the quantification of which provides decision makers and LMS administrators with a blueprint of the most acute issues involving from procedural, attitudinal and technical problems to e-assessment, lesson layout, instruction quality, content quality and communications.

Several of these problems were also brought up by faculty members participating in the 2019 survey.

There is generally a high degree of convergence between both groups (faculty, students) participating in the 2019 survey about the eClass educational impact over all examined aspects. Except in the case of discussion groups where faculty seemed to overestimate their effectiveness compared to their restrained appreciation by students, while faculty underestimated the instructor feedback impact as traditionally faculty is more consumed in administrative efficiencies. In comparison to the educational impact acknowledged by participants in the 2012 survey, there seems to be little variation in the high impact of online study material and quizzes to the learning and teaching process. Participation in discussion groups is still less appreciated while instructor feedback is among higher rated aspects (figure 3).

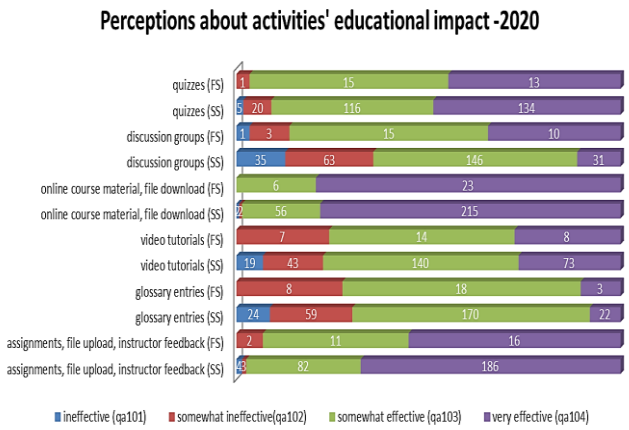

Figure 3. Educational impact

As to the survey item Q11 on eClass usefulness, it may be interesting to note that the findings analysis revealed student problems with the system's learning curve and the system's contribution to foster the sense of community among participants. They were also less optimistic than faculty about the possibility of improving the system and its contribution to improving instruction quality (figure 4).

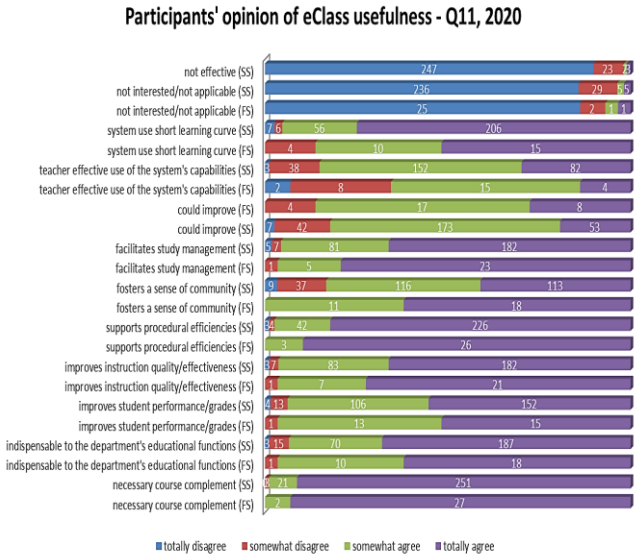

Figure 4. eClass usefulness

In regards to the platform's evaluation over the availability, support, speed and ease of use dimensions between the two different participant cohorts, there is a slight increase in student satisfaction with the system's availability, speed and easiness of use between 2012 and 2019. However, there is a drop where support is concerned while faculty seems more satisfied with support, availability and ease of use now than before. Nevertheless, faculty has manifested a disappointment about speed which may suggest the necessity to conduct an infrastructural capabilities evaluation to detect any potential technical issues resulting in the expressed frustration (figure 5).

Faculty attribute greater importance to content uploads, assignment feedback and announcements and less attention to interactive/synchronous communications which explains to some extent the student disappointment and rising disinterest in the use of the system (figure 5).

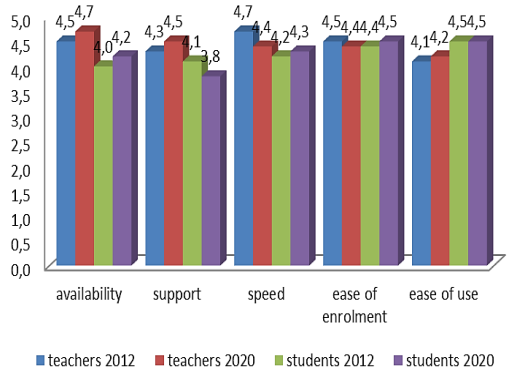

Figure 5. eClass overall evaluation

To statistically test whether there is a relationship between the explanatory variables related to students' appreciation of the system and student demographics such as study program, year of admission and frequency/duration of eClass use, a regression analysis was conducted. The regression showed a statistically significant relationship between admission year, availability and ease of use. There was also a correlation between the study program (undergraduate, postgraduate) visit frequency and the students' appreciation of the availability, speed and ease of use of the system. Therefore, the more recent their registration, the more they visit the platform and the higher they appreciated the system's functionalities aspect. This conclusion partly agrees with the findings in Xu and Mahenthiran's study **[17]**, asserting that most recent cohorts, freshmen and sophomore students, are more comfortable with the assessment and access functionalities of Moodle as compared to juniors and seniors; a fact possibly explained by their greater familiarity with the technology and the lack of past experiences in face-to-face courses.

V. CONCLUSIONS

It seems from the comparison of the two researches (surveys), the two eClass evaluations in 2012 [**24]** and 2019, that there is acceptance of the eClass both from the faculty and the students. The current evaluation (in 2019), reveals more critical findings from the survey in 2012 **[24]**, because there was a transmission from a Technological status, the TEI of Athens, to a University status, the University of West Attica. So, there are more opinions from postgraduate students (because the ALIS master program started in 2018) and more experience in undergraduate students, which is normal because the ALIS eClass installation and use is approximately 10 years. Both, faculty and students agree that the eClass is essential for the Department's courses and program (undergraduate and postgraduate). The communication and the interactions between the eClass platform and the users (faculty and students) has been very

well established. The Moodle installation is very convenient for the faculty and students. The eClass use has been increased since 2012.

The overall evaluation of the eClass reveals that the strategic goals of the ALIS Dept (administration), which is the enhancement of the eClass platform and its maintenance by faculty members is a fruitful choice.

However, the lack of resources (human and financial) reveals some problems and thoughts about the transmission from the ALIS eClass to the University eClass, which is also a Moodle installation. This needs further research (survey), because the ALIS eClass has a very well-established interaction with the faculty and students, something that is not guaranteed if there is a transmission and migrations to the UNIWA eClass.

VI. References

[1] Kampa, R. K. (2017). Bridging the gap: Integrating the library into moodle learning management system a study. *Library Hi Tech News*, 34(4), pp. 16-21, 10.1108/LHTN-11-2016-0055.

[2] Gambo, Y., & Shakir, M. Z. (2019). New development and evaluation model for self-regulated smart learning environment in higher education. *IEEE Global Engineering Education Conference, EDUCON*, April 2019, 990-994, 10.1109/EDUCON.2019.8725268.

[3] Liberona, D., & Fuenzalida, D. (2014). Use of Moodle platforms in higher education: a Chilean case. *International Workshop on Learning Technology for Education in Cloud*, pp. 124-134. Springer, Cham.

[4] Todos, P., Vîrlan, P., & Ghencea, C. (2017). Quality assurance in online education - in the tehnical university of Moldova experience. *Proceeding of the 11th International Conference on Electromechanical and Power Systems, SIELMEN 2017*, 2017, January, pp. 370-374, 10.1109/SIELMEN.2017.8123351.

[5] Kabassi, K., Dragonas, I., Ntouzevits, A., Pomonis, T., Papastathopoulos, G., & Vozaitis, Y. (2016). Evaluating a learning management system for blended learning in greek higher education. *SpringerPlus*, 5(1), pp. 1-12, 10.1186/s40064-016-1705-8.

[6] Al-Ajlan, A., & Zedan, H. (2008). Why moodle. *12th IEEE International Workshop on Future Trends of Distributed Computing Systems*, pp. 58-64.

[7] Costello, E. (2013). Opening up to open source: looking at how Moodle was adopted in higher education. *Open Learning: The Journal of Open, Distance and e-Learning*, 28(3), pp. 187-200.

[8] Bhuasiri, W., Xaymoungkhoun, O., Zo, H., Rho, J. J. and Ciganek, A. P. (2012), Critical success factors for e-learning in developing countries: a comparative analysis between ICT experts and faculty. *Computers & Education*, 58(2), pp. 843–855.

[9] Duygu, F., Alkiş, N., & Ozkan-Yildirim, S. (2018). A structural model for students' adoption of learning management systems: an empirical investigation in the higher education context. *Educational Technology and Society*, 21(2), pp. 13-27.

[10] Siemens, G. 2006. *Learning Management System? A review of Learning Management Systems*, Leanring Technologies Centre, ltc.umanitoba.ca/wordpress/wpcontent/uploads/2006/10/learning-or-management-system-with-reference-list.doc

[11] Cavus, N. (2013). Selecting a learning management system (LMS) in developing countries: instructors' evaluation. *Interactive Learning Environments*, 21(5), pp. 419-437, 10.1080/10494820.2011.584321.

[12] Costa, C., Alvelos, H., & Teixeira, L. (2012). The use of Moodle e-learning platform: a study in a Portuguese University. *Procedia Technology*, 5, pp. 334-343.

[13] El-Bahsh, R., & Daoud, M. (2016). Evaluating the use of Moodle to achieve effective and interactive learning: A case study at the German Jordanian University. *Proceedings of the 35th annual IEEE International Conference on Computer Communications*, pp. 1-5.

[14] Graham, C., Cagiltay, K., Lim, B. R., Craner, J., & Duffy, T. (2001). Seven principles of effective teaching: A practical lens for evaluating online courses. *The Technology Source*, www.technologysource.org/article/seven_principles_of_effective_teaching.

[15] Guasch, T., Alvarez, I., & Espasa, A. (2010). University teacher competencies in a virtual teaching/learning environment: analysis of a teacher training experience. *Teaching and Teacher Education*, 26(2), pp. 199-206, dx.doi.org/10.1016/j.tate.2009.02.018.

[16] Salmon, G. (2004). *E-moderating: the key to teaching and learning online*. London: Routledge Falmer.

[17] Xu, H., & Mahenthiran, S. (2016). Factors that influence online learning assessment and satisfaction: using Moodle as a Learning Management System. *International Business Research*, 9(2), pp. 1-18.

[18] Karagiannis, I., & Satratzemi, M. (2016). A technique to enhance motivational appeal of Moodle: design and evaluation. *Proceedings of the European Conference on e-Learning, ECEL 2016*, January, pp. 350-356.

[19] Seman, S. A. A., Hashim, M. J., Roslin, R. M., & Ishar, N. I. M. (2019). Millennial learners' acceptance and satisfaction of blended learning environment. *Asian Journal of University Education*, 15(3), pp. 129-141.

[20] Xiao, J. (2010). Integrating information literacy into blackboard: librarian-faculty collaboration for successful student learning. *Library Management*, 31(8), 654-668, 10.1108/01435121011093423.

[21] Damnjanovic, V., Jednak, S., & Mijatovic, I. (2015). Factors affecting the effectiveness and use of Moodle: students' perception. *Interactive Learning Environments*, 23(4), pp. 496-514.

[22] Keller, C., Hrastinski, S., & Carlsson, S. A. (2007). Students´ acceptance of e-learning environments: a comparative analysis in Sweden and Lithuania. *Proceedings of the 15th European conference on information systems*, St. Gallen, Switzerland, pp. 395–406.

[23] Liaw, S. S., Huang, H. M., & Chen, G. D. (2007). Surveying instructor and learner attitudes toward e-learning.

Computers & Education, 49, pp. 1066–1080, 10.1016/j.compedu.2006.01.001.

[24] Zervos, S., Kyriaki-Manessi, D., Koulouris, A., Giannakopoulos, G., & Kouis, D. (2013). Evaluation of the e-class platform of the LIS Dept., TEI of Athens. *Procedia – Social and Behavioral Sciences*, 73, pp. 727-735, 10.1016/j.sbspro.2013.02.111.

[25] Olmos-Migueláñez, S., Martínez-Abad, F., Torrecilla-Sánchez, E. M., & Mena-Marcos, J. J. (2014). Psychometric analysis of a perception scale on the usefulness of Moodle in the university. [Análisis psicométrico de una escala de percepción sobre la utilidad de moodle en la Universidad] *RELIEVE - Revista Electronica De Investigacion y Evaluacion Educativa*, 20(2), 1-19, 10.7203/relieve.20.2.4221.

[26] Holmes, K. A., & Prieto-Rodriguez, E. (2018). Student and staff perceptions of a learning management system for blended learning in teacher education. *Australian Journal of Teacher Education*, 43(3), pp. 21-34.

[27] Sánchez-Santamaría, J., Ramos-Pardo, F. J., & Sánchez-Antolín, P. (2012). The student's perspective: teaching usages of Moodle at University. *Proceedings of ICERI 2012 Conference*, 19th-21st November, pp. 2968-2973.

[28] Tickle, K., Muldoon, N., & Tennent, B. (2009). Moodle and the institutional repositioning of learning and teaching at CQ university. *ASCILITE 2009 - the Australasian Society for Computers in Learning in Tertiary Education*, pp. 1038-1047.

[29] Zoran, A. G., & Rozman, K. (2010). Students perceptions of using Moodle. *4th International Conference Proceedings*, Koper, vol. 21, www.fm-kp.si/zalozba/isbn/978-961-266-066-6/prispevki/gorenc-rozman.pdf.

[30] Oliver, M. & Trigwell, K. (2005). Can 'blended learning' be redeemed?. *E-Learning*, 2(1), pp. 17-26.

[31] Valiathan, P. (2002). Blended learning models. *Learning Circuits*, www.purnima-valiathan.com/wp-content/uploads/2015/09/Blended-Learning-Models-2002-ASTD.pdf

[32] Mei, L., Yuhua, N., Peng, Z., & Yi, Z. (2009, December). Pedagogy in the information age: Moodle-based blended learning approach. *2009 International Forum on Computer Science-Technology and Applications*, vol. 3, pp. 38-40. IEEE.

[33] Saputra, Y. A., Singgih, M. L., Latiffianti, E., Suryani, E., & Mudjahidin. (2018). A study on course management system implementation in Indonesian higher education institutions. *IOP Conference Series: Materials Science and Engineering*, 337(1), 10.1088/1757-899X/337/1/012059.

[34] Leontyeva, I. A. (2018). Modern distance learning technologies in higher education: introduction problems. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(10), pp. 1-8, 10.29333/ejmste/92284.

[35] Georgouli, K., Kantzavelou, I., Guerreiro, P., & Koilias, C. (2006). Enhancing student learning using asynchronous e-learning platforms. *Proceedings of the International Conference on Cognition and Explanatory Learning in Digital Age (CELDA 2006)*, pp. 73-80.

[36] Kyrgios, N. (2018), *Digital divide and higher education: exploring the relationship between the social characteristics of students and the use of the internet for the use of e - courses*. Doctoral thesis, University of Ioannina, hdl.handle.net/10442/hedi/44099.

[37] Walker, D., Livadas, L., & Miles, G. (2011). Key influencing factors behind Moodle adoption in Irish small to medium sized higher education colleges. *European Journal of Open, Distance and E-learning*, 14(1).

[38] Palmer, S., & Holt, D. (2014). Development of student and academic staff perceptions of the elements of an online learning environment over time. *Australasian Journal of Educational Technology*, 30(4).

[39] Mestan, K. (2019). Create a fine blend: An examination of institutional transition to blended learning. *Australasian Journal of Educational Technology*, 35(1), 70-84, 10.14742/ajet.3216.

[40] Shaidullin, R. N., Safiullin, L. N., Gafurov, I. R., & Safiullin, N. Z. (2014). Blended learning: leading modern educational technologies. *Procedia – Social and Behavioral Sciences*, 131, pp. 105-110.

[41] Weaver, D., Spratt, C., & Nair, C. S. (2008). Academic and student use of a learning management system: implications for quality. *Australasian Journal of Educational Technology*, 24(1), 10.14742/ajet.1228.

[42] Morgan G. (2003). *Faculty Use of Course Management Systems*, www.educause.edu/ir/library/pdf/ers0302/rs/ers0302w.pdf

[43] Malikowski, S., Thompson, M., & Theis, J. (2006). External factors associated with adopting a CMS in resident college courses. *The Internet and Higher Education*, 9(3), pp. 163-174.

[44] Martín-Blas, T., & Serrano-Fernández, A. (2009). The role of new technologies in the learning process: Moodle as a teaching tool in Physics. *Computers & Education*, 52, 35–44, 10.1016/j.compedu.2008.06.005.

[45] Reinhart, C.J. (2008) Constructing the Café University: teaching and learning on the digital frontier. *On the Horizon*, 16(1), pp. 13-33, 10.1108/10748120810853327.

[46] Tselios, N.K., Daskalakis, S., & Papadopoulou, M. (2011). Assessing the Acceptance of a blended learning university course. *Educational Technology & Society*, 14, pp. 224-235.

[47] Reeves, T. (2000). Alternative assessment approaches for online learning environments in higher education. *Journal of Educational Computing Research*, 23(1), pp. 101-111, 10.2190/GYMQ-78FA-WMTX-J06C.

[48] Teo, T., Zhou, M., Fan, A. C. W., & Huang, F. (2019). Factors that influence university students' intention to use Moodle: a study in Macau. *Educational Technology Research and Development*, 67(3), pp. 749-766.

VII. AUTHORS

Alexandros Koulouris is Assistant Professor in the Department of Archival, Library & Information Studies at the University of West Attica. He has been involved in several European and national R&D projects in the field of information management (DELOS, EuropeanaLocal, Europeana, CrossCult). From 2011, he actively participates in Europeana as a member of the Europeana Network Association. He is member of the Information Management laboratory at the University of West Attica. His research interests include information policy, digital libraries, repositories and open access. He has published more than 45 articles in journals and conferences. In the past, he has worked as a librarian for the National Technical University of Athens and for the National Documentation Centre of Greece. He holds a PhD in Information Science from Ionian University, a BA in Library Science from the Technological Educational Institute of Athens and a BA (Hon) in International and European Studies from Panteion University. More information can be found at users.uniwa.gr/akoul.

Hypatia Digital Library: A novel text classification approach for small text fragments

Ioannis Triantafyllou, Frosso Vorgia, Alexandros Koulouris
Department of Archival, Library & Information Studies, University of West Attica, Athens, Greece
triantafi@uniwa.gr [**ORCID:** 0000-0001-5273-0855], frossovorgia@gmail.com, akoul@uniwa.gr
[**ORCID:** 0000-0002-4011-2678]

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Abstract:

Purpose - *The purpose of this paper is to further investigate prior work of the authors in text classification in Hypatia, the digital library of University of Western Attica. The main objective is to provide an accurate automated classification tool as an alternative to manual assignments.*

Design/methodology/approach - *The crucial point in text classification is the selection of the most important term-words for document representation. The specific document collection consists of 718 abstracts in Medicine, Tourism and Food Technology. Two weighting methods were investigated: classic TF.IDF and DEVMAX.DF. The last one was proposed by the authors as a more accurate term-word selection tool for smaller text fragments. Classification was conducted by applying 14 classifiers available on WEKA.*

Findings - *Classification process yielded an excellent ~97% precision score and DEVMAX.DF proved to perform better than classic TF.IDF.*

Index Terms — Digital libraries, Statistical natural language processing, Text classification, WEKA, Word stemming.

I. Introduction

Subject classification in libraries is conducted manually with the use of classification systems, subject headings, thesauri and ontologies. This time-consuming process has been adopted for the digital libraries as well **[1].** However, considering the immense and continuous creation of digital objects, a new method of fast classification is required **[2]**.

The purpose of the present work is to employ the text classification method in digital libraries as an alternative solution to the aforementioned problem. Text classification is applied on small text fragments such as the abstracts of the digital objects. Abstracts are considered to be the best option to experiment with as they might be the only available texts which represent the content of resources, since full text is not always available due to copyright constraints. The abstracts are mainly extracted from Hypatia, the digital library of University of Western Attica (former Technological Educational Institute (T.E.I.) of Athens).

In a previous research **[3]** we applied and made measurements of abstract representation by word weighting with TF.IDF. Nevertheless, the results were unsatisfactory and this created the need to reexamine this work with the use of a new weighting method called DEVMAX.DF, which is introduced here. In the final phase, - classification algorithms provided by the open source software WEKA are used **[4, 5]**.

II. Related work

Text classification/categorization (TC) is the task of classifying texts in predefined classes **[6]**. So far TC has been utilized in a machine learning approach, conducted with the use of classifiers (algorithms). The most extensively used ones for TC are Naïve Bayes and Naïve Bayes Multinomial **[7].** However, there are more classifiers, such as Support Vector Machines (SVM), Multilayer Perceptron, IBk, Decision Table, Random Forest etc. which can be exploited **[8]**. Especially in the environment of a digital library which hosts entire collections of documents, scientific papers, dissertations, datasets, images and sounds, TC can be advantageous for browsing and retrieval **[9]**.

Classification techniques have achieved encouraging outcomes in many applications regarding small to medium text fragments, like those already provided by digital libraries (abstracts). One application is the common and ever evolving problem of spam emails. The solution is e-mail filtering to prevent phishing and labeling as spam or ham **[9, 10, 11, 12]**. Likewise, in the field of telecommunications, the approach of TC has been used for SMS labeling similarly **[13, 14, 15]**.

Additionally, microblogging services are valuables sources of small texts. In Twitter, for example, a vast number of Tweets are produced every day. Focused analyses, such as Twitter trending toppings' classification **[16]**, sentiment analysis on financial related Tweets **[17]**, suicidal expressions [18], and recognition of pornographic material **[19]** have produced positive results. In addition, these techniques can overcome language barriers as they can be employed with English, Dutch, Indonesian, or even Chinese **[19, 20, 21]**.

III. Methodology

The initial idea was that TC would be applied on full texts, but inevitably, - some problems due to access limitations were arisen. Therefore, there was made an effort to collect

keywords in order to weigh the words in classes with TF.IDF. However, this approach would produce patently obvious results, so it was abandoned. Eventually, the research team adopted the methodology described in the sections below.

A. Data collection

- 718 abstracts were collected, considering that they are in Greek and already classified either in Medicine or Tourism or Food Technology, as these classes were the most p frequent). Although, Hypatia was the main source of abstracts, it was considered scientifically sound to extract data from more sources. Thus, the research team decided to derive abstracts from other digital libraries aiming to create a balanced corpus for the three classes. Analytically, abstracts were assembled from the following 9 Greek academic digital libraries and repositories.

- Hypatia - University of Western Attica (512),
- The digital repository of Agricultural University of Athens (AUA) (73),
- Eureka! - T.E.I. of Thessaloniki (47),
- Dioni - University of Piraeus (45),
- Psepheda - University of Macedonia (19),
- DSpace - National Technical University of Athens (11),
- Nemertes - University of Patras (9),
- E-Locus - University of Crete (1),
- Anaktisis - T.E.I. Institute of Western Macedonia (1).

However, each digital library applies different subject classification tools to assign the subject categories. In order to ensure uniformity and accordance in the dataset, Dewey Decimal Classification was used as a guide to include or discard the abstracts. The only exception was a set of 22 abstracts from the digital repository of Agricultural University of Athens. These concerned theses from the department of Science and Food Technology, which also included relevant words, so they were considered to have a connection to Food Technology.

The final text corpus consisted of 373 abstracts in Medicine, 223 in Tourism and 122 in Food Technology.

B. Text Handling and Word Stemming

Initially, a basic text pre-processing is necessary to minimize the noise. A system of natural language communication includes nouns, verbs, adverbs, conjunctions, etc. Not every part of speech has useful meaning. For example, the word "και" ("and" in English) has no special meaning, regardless of how many times it appears in a text. These kinds of words are called "stop words" and have to be removed **[22]**.

In addition, it is essential to stem the words of the texts. Greek is a highly inflected language, meaning that almost every word in a sentence has an affix. Stemming, or conflation, is the process of reducing the words to their stem by taking off the affixes **[23]**.

Basic text pre-processing is based on text handler **[8]**, a tool having the responsibility of transforming a text from abstracts into a form suitable for the manipulation required by the application:

- identification of textual units at the level of sentences by using trivial delimiters, such as spaces, stops, question marks, etc.
- identification of extra-linguistic elements, such as dates, abbreviations, acronyms, list enumerators, numbers, etc.

Subsequent to words' identification, the word stemming, or term conflation process is performed. During the latter, the system captures the morphological variations of terms located in the abstracts. Term spotting process is performed in two subsequent phases. The first phase aims at reducing the search space thus improving the performance of the system. During this phase, a small set of candidate similar words, based on statistical information, has been extracted and grouped together under a common representative term.

Consequently, during the second phase a more elaborate procedure occurs, where the system ranks the located terms and produces a complete term "short-list" for each candidate term of the input text. The score mechanism is based on the similarity estimator (Eq. 1), especially designed to assign higher scores to morphological variations of the same root form.

$$\textbf{Similarity (W1, W2) = Common Position Trigrams (Left(W1, L) , Left(W2, L)) / L} \quad (1)$$

$$\textbf{where L = (Length(W1) + Length(W2)) / 2, L}\epsilon\textbf{N}$$

Efficient grouping of words in terms has been achieved with a similarity score of 66,6%.

C. Abstract Representation

Special consideration has been granted to the selection of the feature space, a crucial aspect in the performance of any text classification model. Any term-word within the abstracts corpus constitutes a candidate feature with the exception of functional words that are excluded based on stop-lists. Feature selection consists of reducing the vocabulary size of the training corpus by selecting term-words with the highest indicative efficiency over the class variable.

The TF.IDF metric **[23, 24]** is one classic approach to sort the candidates' term-words in a list by scoring their correlation importance to the class variable. In our case TF is the frequency of feature f within the corpus, and IDF is the logarithm of N/Nf, where N is the total number of abstracts and Nf is the number of abstracts containing the feature f. The selected features are the most dominant ones based on that score.

After experimenting with TF.IDF it was observed that a lot of irrelevant term-words, with appearance in all classes, were sorted highly in the importance list. Hence, there was made a decision to introduce a new metric which would promote the term-words appearing mainly in one or more classes but not entirely. The intention was to promote term-words that have the maximum deviation in appearances (in other words the minimum appearances) in other classes from the main (max) class, the class in which they mostly appear. In order to promote high appearance term-words the formula is further regulated with the logarithm of the DF,

the number of abstracts containing the term-word F. The metric with the proposed name DEVMAX.DF is described in the following equation (Eq. 2)."

$$DEVMAX.DF = \sqrt{\frac{\sum_{i=1}^{c}(DF_i/N_i - max)^2}{(c-1)*max^2}} * \log(DF), \quad where \max = maximum_{i=1}^{c} DF_i/N_i \tag{2}$$

DFi is the number of abstracts containing the term-word F in class i, Ni is the number of abstracts in class i and c is the number of classes. The comparison between the two methods is presented in Table 1, where the metric obviously has managed to promote more important term-words for the abstract representation; term-words which are related to one class mainly and therefore provide a good correlation importance for the class.

Table 1. First 10 selected term-words in both metrics and their appearances in the 3 classes.

	DEVMAX.DF				**TF.IDF**		
TERM-WORD	*Medicine*	*Tourism*	*Food*	**TERM-WORD**	*Medicine*	*Tourism*	*Food*
ΤΟΥΡΙΣΜΟ *(TOURISM)*	0	187	0	ΤΟΥΡΙΣΜΟ *(TOURISM)*	0	187	0
ΝΟΣΗΛΕΥΤΗΚΑΝ *(HOSPITALISED)*	129	0	0	ΑΣΘΕΝΩΝ *(PATIENTS)*	194	2	9
ΝΟΣΟΚΟΜΕΙΟ *(HOSPITAL)*	101	0	0	ΝΟΣΗΛΕΥΤΗΚΑΝ *(HOSPITALISED)*	129	0	0
ΑΣΘΕΝΩΝ *(PATIENTS)*	194	2	9	ΥΓΕΙΑΣ *(HEALTH)*	147	5	14
ΦΡΟΝΤΙΔΑ *(CARE)*	70	0	0	ΠΑΙΔΙΑ *(CHILDREN)*	49	1	4
ΓΥΝΑΙΚΕΣ *(WOMEN)*	68	1	0	ΑΝΑΠΤΥΣΣΕΙ *(DEVELOPS)*	66	112	48
ΚΛΙΝΙΚΗ *(CLINIC)*	85	1	2	ΠΟΙΟΤΗΤΑΣ *(QUALITY)*	85	39	28
ΤΡΟΦΙΜΩΝ *(FOOD)*	2	1	56	ΜΕΘΟΔΟΥΣ *(METHODS)*	204	34	56
ΘΕΡΑΠΕΙΑΣ *(THERAPY)*	104	3	4	ΑΝΑΓΚΕΣ *(NEEDS)*	151	88	53
ΑΝΑΣΚΟΠΗΣΗ *(REVIEW)*	98	8	1	ΕΚΠΑΙΔΕΥΤΙΚΩΝ *(EDUCATIONAL)*	88	14	2

An additional important issue to consider is the frequency of a term-word when determining the abstract vector. There are cases where a term-word is more indicative to the relevance of the abstract when it appears several times. However, this is not always true since long abstracts usually introduce a lot of noise. The research team experimented with two alternatives concerning the strength of the selected features: the binary (boolean) appearance (0 or 1), and the actual value of the term frequency in the abstract. Thus, the experimental methods consist of four possible combinations based on two axes, the importance metric on which the selection of feature space is based and the strength of the representative feature: TF.IDF-bin, TF.IDF-tf, DEVMAX.DF-bin and DEVMAX.DF-tf.

D. Text Classification with WEKA

Following the extraction of the most important words in the corpus, the abstract representation sampling consisted of 10, 15, 20, 25, 50, 75, 100, 150, 200, 300, 500 and 750 term-words. In order to achieve accurate estimation, a 10-fold cross-validation method was used. Precision Recall and F-score were the evaluation metrics applied for comparing and evaluating the performance of classifiers.

The tool that was used to apply the classifiers was WEKA. It gathers together algorithms for classification, regression, clustering, association rules, visualization and algorithm development. The program is written in Java and it was developed at the University of Waikato in New Zealand **[4, 6]**.

The classifiers were chosen from version 3.7.12 of WEKA for developers. These were:

- Two Bayesian classifiers: Naïve Bayes and Naïve Bayes Multinomial,
- Three Function classifiers: Multilayer Perceptron, Simple Logistic, and SMO(SVM),
- Two Lazy classifiers: IBk and Kstar,
- Two Metalearning classifiers: Classification Via Regression and Logit Boost,
- Three Rule classifiers: Decision Table, JRip, and PART,
- Two Tree classifiers: LMT and Random Forest.

Table 2. F-score (%) with words from DEVMAX.DF.

Vector Size	10W	15W	20W	25W	50W	75W	100W	150W	200W	300W	500W	750W

	Classifier												
BIN	*NaïveBayes (NB)*	89,9	92,5	92,8	93,0	93,6	94,1	94,4	95,1	95,5	95,3	95,6	95,8
	NBMultinomial	87,0	89,3	91,8	94,2	95,1	95,9	96,0	96,1	96,2	95,8	95,9	96,3
	MLP	89,5	92,9	92,3	92,4	93,8	94,2	94,5	96,1	95,5	96,6	fail	fail
	SimpleLogistic	90,0	92,9	91,8	94,3	96,1	96,4	97,0	97,1	96,4	96,9	96,5	96,0
	SMO	89,0	92,9	91,8	93,3	95,3	96,4	96,0	96,2	96,1	97,2	97,1	96,7
	IBk	89,9	92,6	92,7	93,5	92,4	91,9	92,3	90,5	85,8	82,1	73,0	71,1
	Kstar	90,2	92,9	92,5	92,2	92,4	91,9	92,2	90,6	87,2	84,2	76,4	73,2
	Class.ViaRegress.	86,2	86,4	88,7	90,5	93,5	94,2	94,6	94,5	93,7	95,2	95,2	95,2
	LogitBoost	87,2	90,7	91,8	94,3	94,6	96,2	95,5	96,3	96,3	96,0	96,1	96,1
	DecisionTable	86,8	89,0	90,8	91,6	91,5	91,0	91,8	91,0	91,0	92,0	91,7	91,4
	JRip	86,5	92,4	90,9	92,0	92,2	93,1	94,1	93,7	93,3	93,6	93,0	93,5
	PART	89,8	92,0	92,7	92,5	92,3	93,5	94,9	94,1	94,0	93,2	93,6	94,3
	LMT	90,0	92,9	93,2	94,3	96,1	96,4	96,8	96,9	96,2	96,9	96,2	96,0
	RandomForest	90,0	92,8	93,1	93,0	93,8	94,6	95,8	96,4	97,1	97,5	96,9	97,2
TF	*NB*	79,9	87,7	87,2	90,5	90,4	91,1	91,4	91,9	92,8	94,2	94,8	95,0
	NBMultinomial	87,2	89,4	92,6	94,8	95,7	95,8	95,9	96,5	96,3	96,5	96,1	97,2
	MLP	88,4	91,7	91,7	93,0	93,6	93,7	92,6	93,0	92,5	91,3	fail	fail
	SimpleLogistic	87,2	92,7	92,8	95,2	95,4	96,2	96,0	96,0	96,0	94,6	95,4	94,6
	SMO	80,8	83,9	89,2	91,3	95,1	95,2	94,9	93,4	94,7	94,8	95,6	95,1
	IBk	89,5	91,8	92,1	93,3	88,1	87,0	85,9	86,3	85,8	80,0	77,5	73,2
	Kstar	90,2	92,6	91,6	92,3	90,6	89,7	88,9	87,7	83,8	79,9	74,4	72,0
	Class.ViaRegress.	87,3	87,0	88,5	89,6	93,1	92,9	93,2	93,3	93,6	93,8	93,8	94,0
	LogitBoost	87,2	90,7	91,8	94,2	94,9	95,6	95,6	96,3	96,3	95,7	95,3	95,3
	DecisionTable	86,8	89,0	90,8	91,2	91,3	90,9	91,8	91,0	91,0	92,0	91,7	91,4
	JRip	86,7	92,3	90,7	90,8	92,2	93,3	93,0	93,7	93,6	94,3	93,7	93,4
	PART	89,4	91,9	92,9	93,0	93,4	93,3	93,8	94,2	94,2	93,8	94,2	92,9
	LMT	89,6	92,3	93,2	95,2	95,4	96,2	95,8	95,1	96,0	94,6	95,1	94,3
	RandomForest	90,0	92,6	92,3	93,0	93,6	94,3	96,4	96,6	96,4	97,6	97,6	96,6

Table 3. F-score (%) with words from TF.IDF.

	Vector Size	10W	15W	20W	25W	50W	75W	100W	150W	200W	300W	500W	750W
	Classifier												
BIN	*NaïveBayes(NB)*	83,9	83,5	84,6	86,9	92,3	93,0	93,3	93,1	93,3	94,8	93,3	95,8
	NBMultinomial	77,3	82,3	85,5	88,8	93,8	94,9	94,7	94,8	93,2	95,5	95,1	96,3
	MLP	81,9	82,6	83,9	87,5	92,9	95,1	95,1	95,2	95,6	96,3	fail	fail
	SimpleLogistic	80,4	83,2	86,1	87,7	93,5	94,9	95,6	95,9	96,7	95,7	96,4	96,0
	SMO	84,7	83,5	86,0	87,5	92,2	93,3	93,6	94,6	95,7	95,9	95,8	96,7
	IBk	81,6	80,6	80,6	85,6	86,0	86,5	87,1	83,2	80,2	79,3	67,8	71,1
	Kstar	81,7	81,0	82,8	86,4	87,0	88,5	87,7	84,5	82,0	80,7	70,4	73,2

	Class.ViaRegress.	81,7	84,6	86,3	87,0	91,9	93,7	93,8	93,4	93,6	94,0	93,7	95,2
	LogitBoost	81,7	82,4	84,8	88,3	92,4	94,0	94,5	94,7	94,4	96,0	95,8	96,1
	DecisionTable	82,3	81,5	83,3	81,6	89,0	92,5	92,0	92,0	91,7	92,0	92,1	91,4
	JRip	79,5	81,6	83,7	83,3	90,2	91,3	93,2	92,0	92,7	90,4	92,0	93,5
	PART	82,2	81,9	84,2	86,7	90,0	92,0	92,1	92,3	93,0	92,6	93,1	94,3
	LMT	80,8	82,8	86,3	87,7	93,5	94,9	96,0	95,9	96,5	95,7	96,4	96,0
	RandomForest	82,2	82,4	86,1	89,2	93,6	95,8	96,7	96,3	96,7	97,4	96,6	97,2
	NB	74,0	75,9	77,7	80,2	85,7	87,9	89,2	90,1	91,0	92,8	93,0	93,0
	NBMultinomial	81,3	83,3	86,0	87,1	92,5	94,8	94,5	95,2	95,8	97,3	96,7	96,6
	MLP	80,8	81,8	84,1	87,9	91,6	94,8	92,9	93,4	91,7	84,8	fail	fail
	SimpleLogistic	82,1	84,5	86,9	87,9	93,7	94,4	95,2	94,2	94,7	95,0	95,3	95,0
	SMO	76,9	78,9	81,0	83,8	90,2	93,1	92,6	93,0	93,4	94,3	92,9	94,1
	IBk	75,7	75,9	76,2	80,0	79,4	82,5	79,6	78,2	75,8	75,9	72,0	66,0
TF	*Kstar*	79,6	77,6	79,8	80,4	80,1	80,7	77,1	73,4	72,2	70,1	60,5	57,9
	Class.ViaRegress.	81,3	84,6	86,1	87,2	90,1	92,8	93,0	91,6	92,3	92,3	92,3	92,3
	LogitBoost	80,8	83,8	85,8	87,9	92,6	94,7	94,0	94,3	94,4	96,0	95,7	95,3
	DecisionTable	82,0	83,0	81,7	81,9	89,5	92,5	91,9	91,5	91,5	91,8	91,9	92,0
	JRip	80,8	81,1	81,7	83,2	90,3	92,0	92,1	92,7	92,0	91,4	91,6	91,6
	PART	80,9	81,9	83,4	83,9	90,9	92,3	91,7	92,2	92,1	91,5	91,4	90,8
	LMT	82,1	84,2	86,9	87,9	93,7	94,7	95,0	94,3	94,7	95,0	95,3	95,0
	RandomForest	81,0	85,5	87,6	89,7	93,2	95,4	96,8	96,2	96,6	96,3	97,0	97,4

Table 4. Results (%) of the best classifiers.

Classifier	***Method***	***Vector***	***F-score***	***Precision***	***Recall***
RandomForest	DEVMAX.DF-tf	500W	97,60	97,60	97,60
RandomForest	DEVMAX.DF-bin	300W	97,50	97,50	97,50
RandomForest	TF.IDF-bin	300W	97,40	97,40	97,40
RandomForest	TF.IDF-tf	750W	97,40	97,40	97,40
NBMultinomial	TF.IDF-tf	300W	97,25	97,30	97,20
NBMultinomial	DEVMAX.DF-tf	750W	97,20	97,20	97,20
SMO	DEVMAX.DF-bin	300W	97,20	97,20	97,20
SimpleLogistic	DEVMAX.DF-bin	150W	97,10	97,10	97,10

Nevertheless, as Table 4 shows, the best classifier was Random Forest which achieved the highest Precision (P), Recall (R) and F-score (F1) rates in all four methods: DEVMAX.DF-bin (binary appearance), DEVMAX.DF-tf (frequency appearance), TF.IDF-bin and TF.IDF-tf. It yielded up to F1=97,6% in DEVMAX.DF-tf and did not fall under F1=97,4% in TF.IDF-bin and TF.IDF-tf. Naïve Bayes Multinomial, SMO (SVM) and Simple Logistic were also achieved F-scores greater than 97%. Naïve Bayes Multinominal performed better with tf and yielded F1=97,25% in TF.IDF and F1=97,2% in DEVMAX.DF. SMO (SVM) and Simple Logistic achieved an F-score of 97,2% and 97,1% respectively in DEVMAX.DF-bin. The excellent results of each classifier were produced from 150 to 750 vector size in word-terms.

Regardless of the method, Random Forest yielded the highest scores. This is no surprise as it is considered one of the most powerful and successful algorithms, with many applications in real life (banking, medicine, stock market, e-commerce, etc.), which can handle very large numbers of

input attributes **[25, 26]**. The specific method, DEVMAX.DF, boosted the algorithm even more.

Moreover, DEVMAX.DF performed better than classic TF.IDF with all the algorithms. This is especially noticeable with smaller vector size, since it manages to correctly detect the best words for document representation earlier than classic TF.IDF. It is also illustrated in Fig. 1 where the average performance of all classifiers is shown for each method individually. DEVMAX.DF has apparently better average performance than TF.IDF especially in small size vectors.

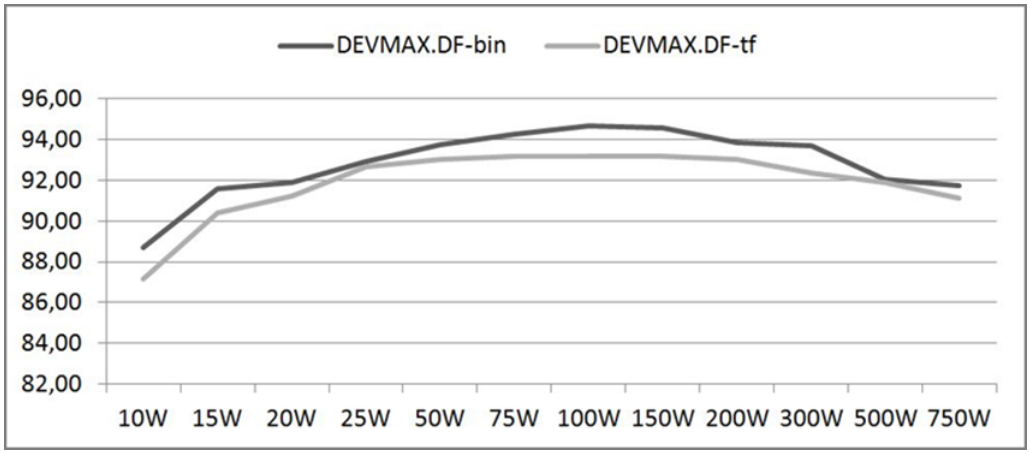

Fig 1. Average F-score (%) performance of all classifiers.

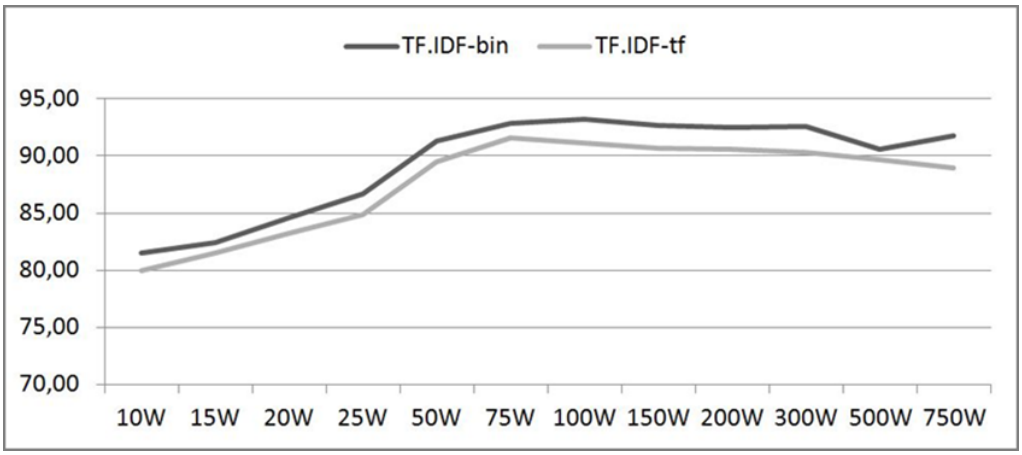

Fig 2. Average F-score (%) performance for all classifiers of binary (bin) and term frequency (tf) representations for DEVMAX.DF.

Another significant observation is that binary representation of document vectors acts in a more beneficiary way than frequency representation in the performance of the examined classifiers. This is illustrated in Fig. 2 and Fig. 3 where the dark gray lines correspond to binary representations while light ones indicate term frequency representations.

IV. Conclusions

An assessment of the use of text classification in digital libraries took place. During the pre-processing, two weighting methods, TF.IDF and DEVMAX.DF with binary and term frequency appearance, were used. The software used to apply classification algorithms was WEKA. Overall, this research indicated that digital libraries could substitute manual classification with the proposed approach. DEVMAX.DF, which proved to be more effective than TF.IDF, produced an F-score greater than 97% in some classifiers. In addition, this method, unlike TF.IDF, yielded adequate results with a small amount of words. However, this raises the question whether the same approach can be exploited with the use of smaller texts.

Hence, in the future the aim is to experiment with titles instead of abstracts. Another important future aspect is to apply clustering techniques to encourage and identify classes and topic fusion.

V. REFERENCES

[1] A. Joorabchi, A. Mahdi, An unsupervised approach to automatic classification of scientific literature utilizing bibliographic metadata, Journal of Information Science, 37(5) (2011) 499-514.

[2] I. Triantafyllou, A. Koulouris, S. Zervos, M. Dendrinos, D. Kyriaki-Manessi, G. Giannakopoulos, Significance of clustering and classification applications in digital and physical libraries, In: Proceedings of 4th International Conference IC-ININFO, Madrid, Spain, 2014.

[3] F. Vorgia, I. Triantafyllou, A. Koulouris., Hypatia Digital Library: A text classification approach based on abstracts, Strategic Innovative Marketing, Springer International Publishing, (2017), 727-733.

[4] R.R. Bouckaert, E. Frank, M.A. Hall, G. Holmes, B. Pfahringer, P. Reutemann, I. H. Witten, WEKA- experiences with a Java open-source project, Journal of Machine Learning Research 11 (2010) 2533-2541.

[5] Machine Learning Group at the University of Waikato, WEKA 3- data mining with open source machine learning software in Java, 2015.

[6] F. Sebastiani, Machine learning in automated text categorization, ACM computing surveys (CSUR) 34 (2002) 1-47.

[7] I. H. Witten, E. Frank, M.A. Hall, Data mining: practical machine learning tools and techniques, Morgan Kaufmann, 2011.

[8] I. Triantafyllou, I. Demiros, S. Piperidis, Two level self-organizing approach to text classification, In: Proceedings of RANLP-2001: Recent Advances in NLP, 2001.

[9] C. C. Aggarwal, C. Zhai, A survey of text classification algorithms, Mining text data (2012) 163-222.

[10] T. S. Guzella, W. M. Caminhas, A review of machine learning approaches to Spam filtering, Expert Systems with Applications 36 (2009) 10206–10222.

[11] L. Huan, Y. Lei, Toward integrating feature selection Algorithms for Classification and Clustering, IEEE Transaction on Knowledge and Data Engineering 17(4) (2005).

[12] R. Islam, J. Abawajy, A multi-tier phishing detection and filtering approach, Journal of Network and Computer Applications 36 (2013) 324–335.

[13] I. Ahmed, R. Ali, D. Guan, Y. K. Lee, S. Lee, T. C. Chung, Semi-supervised learning using frequent itemset and ensemble learning for SMS classification, Expert Systems with Applications, 42(3) (2015) 1065-1073.

[14] S. J. Delany, M. Buckley, D. Greene, SMS spam filtering: Methods and data, Expert Systems with Applications 39 (2012) 9899–9908.

[15] W. Liu, T. Wang, Index-based Online Text Classification for SMS Spam Filtering, Journal of Computers 5(6) (2010).

[16] D. Irani, S. Webb, C. Pu, K. Li, Study of trend-stuffing on twitter through text classification, In: Proceedings of Collaboration, Electronic messaging, Anti-Abuse and Spam Conference (CEAS), 2010.

[17] M. Daniela, R. F. Nevesa, N. Horta, Company event popularity for financial markets using Twitter and sentiment analysis, Expert Systems with Applications 71(1) (2017) 111-124.

[18] B. O'Dea, S. Wan, P. J. Batterham, A. L. Calear, C. Paris, H. Christensen, Detecting suicidality on Twitter, Internet Interventions 2(2) (2015) 183-188.

[19] E. Barfian, B. H. Iswanto, S. M. Isa, Twitter Pornography Multilingual Content Identification Based on Machine Learning, Procedia Computer Science 116 (2017) 129-136.

[20] B. Desmet, V. Hoste, Online suicide prevention through optimised text classification, Information Sciences 439–440 (2018) 61–78.

[21] L. Li, Y. G. Huang, Z. W. Liu, Chinese text classification for small sample set, The Journal of China Universities of Posts and Telecommunications 18 (2011) 83–89.

[22] W. J. Wilbur, K. Sirotkin, The automatic identification of stop words, Journal of Information Science 18 (1992) 45-55.

[23] W. B. Croft, D. Metzler, T. Strohman, Search engines: information retrieval in practice, Addison-Wesley, 2010.

[24] K. S. Jones, A statistical interpretation of term frequency and its application in retrieval, Journal of Documentation 28 1972 11-21.

[25] K. Fawagreh, M. Medhat Gaber, E. Elyan, Random forests: from early developments to recent advancements, Systems Science & Control Engineering 2(1) (2014) 602-609.

[26] A. J. Wyner, M. Olson, J. Bleich, Explaining the Success of AdaBoost and Random Forests as Interpolating Classifiers, Journal of Machine Learning Research 18 (2017)

VI. AUTHORS

Ioannis Triantafyllou is Associate Professor in the Department of Archival, Library & Information Studies at the University of West Attica. He received his Ph.D. from National Technical University of Athens, Department of Electrical and Computer Engineering in 2003.He has worked in the past as a scientific associate in many European and Greek research projects at the Institute for Language and Speech Processing (ILSP / RC "Athena"). Since 2016 he is a member of the research team of the CrossCult European project (Horizon2020). The field of scientific interests and publications are: Digital Libraries, Data Mining, Text Mining, Text Classification & Clustering, Ontologies & Metadata, Information Extraction, Information Retrieval, Automated Summary & Text Synthesis and Translation Memories.

Frosso Vorgia received her bachelor's degree in Library and Information Science from T.E.I. of Athens (currently known as University of West Attica) in 2016. She worked at Uni.Systems as a librarian on several projects since 2017. Her research interests are Digital Libraries, Data analysis, Office management, Sustainable fishing and Fisheries and aquaculture in Eastern Mediterranean Subarea.

Alexandros Koulouris is Assistant Professor in the Department of Archival, Library & Information Studies at the University of West Attica. He has been involved in several European and national R&D projects in the field of information management (DELOS, EuropeanaLocal, Europeana, CrossCult). From 2011, he actively participates in Europeana as a member of the Europeana Network Association. He is member of the Information Management laboratory at the University of West Attica. His research interests include information policy, digital libraries, repositories and open access. He has published more than

45 articles in journals and conferences. In the past, he has worked as a librarian for the National Technical University of Athens and for the National Documentation Centre of Greece. He holds a PhD in Information Science from Ionian University, a BA in Library Science from the Technological Educational Institute of Athens and a BA (Hon) in International and European Studies from Panteion University. More information can be found at users.uniwa.gr/akoul.

Pure cellulose paper ageing in sealed vessels. Autocatalytic depolymerization model revisited

Spiros Zervos[1], Konstantinos Choulis[2] and Georgios Panagiaris[2]
[1] Department of Archival, Library & Information Studies, University of West Attica, Athens, Greece
[2]Department of Conservation of Antiquities & Works of Art, University of West Attica, Athens, Greece
szervos@uniwa.gr [**ORCID:** 0000-0003-1849-5999], kchoulis@uniwa.gr, gpanag@uniwa.gr

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Abstract:

Purpose - *In the framework of the EU funded INVENVORG project (Thales Research Funding Program – NRSF), the natural and artificial ageing of bone, wood, textiles, parchment and paper were investigated.*

Design/methodology/approach - *In this work, the results of accelerated ageing on pure cellulose paper in sealed vessels are reported. The properties studied include the degree of polymerization (which was converted to the percentage of broken glyosidic bonds), the tearing resistance, the pH and the L* and b* coordinates of the CIEL*a*b* color system. Ageing was performed in sealed vessels at 90°C και 76% RH for periods of 20, 40, 60, 80, 100, 120 and 140 days.*

Findings - *The results indicated an overall deterioration of all paper properties, which accelerates with time because of the production of volatile acidic species (autocatalysis). The evolution of paper properties through time was modeled efficiently by use of the equations proposed by Zervos and Moropoulou (2005) for the autocatalytic acid hydrolysis of pure cellulose paper, which were shown that also apply for following the changes of tearing resistance. The applicability of the model equations was also verified for other paper properties, such as the percentage of broken bonds (δ%) and the L* and b* coordinates of the CIEL*a*b* color system.*

Index Terms - *Cellulose ageing model; autocatalysis; tearing resistance; pH; optical properties; sealed vessels*

I. Introduction

Various equations have been proposed to describe the evolution of paper and cellulose properties during accelerated ageing. The Ekenstam **[1]** equation (eq. 1) is the oldest, and its applicability and acceptance are almost universal. It can be derived either by assuming zero order kinetics or as an approximation of first order kinetics, and it applies to heterogeneous conditions, to acid hydrolysis in solutions and to thermal, photochemical and enzymatic degradation of cellulose, at the early stage of the reaction **[2-16]**.

$$\frac{1}{DP_t} - \frac{1}{DP_o} = kt \qquad (1)$$

where DP_t and DP_0 are the Degree of Polymerization values at times t and 0, t the time and k the rate constant.

Variations of eq. 1, but also other equations derived by other approaches, have also been introduced by Calvini, Ding and Wang and others **[17, 18, 19, 20, 21, 22, 23, 24, 16, 25, 26, 27, 28]**, taking into consideration autocatalysis and the slowing of the reaction because of the inaccessibility of the crystalline regions of cellulose.

In a previous paper **[21]**, a kinetic model which applied to the autocatalytic depolymerization of cellulose in sealed vessels was presented. The model introduced a generalized equation (eq. 2) that predicted the evolution of several properties of pure cellulosic paper during accelerated ageing at 80°C and 75% RH, namely the percentage of the broken glycosidic bonds (δ%), the folding endurance, tensile strength, tensile energy absorption, stretch at break and the L* and b* coordinates of the CIEL*a*b* color system.

$$P = P_o \pm C \cdot (2^{k \cdot t} - 1) \qquad (2)$$

where P_o and P are the values of the property P at time 0 and t, and C and k constants.

Equation 2, like the Ekenstam equation, holds for the early stage of degradation, until δ% reaches 0.6–0.7% with a corresponding DP of around 250, which is in the range of reported LODP (Leveling of Degree of Polymerization) values **[2, 5, 7, 16]**. The theoretical and mathematical evolution of the model equation is presented elsewhere **[21]**.

In the present paper, another paper strength property, tearing resistance, was also studied concerning its conformance to the model, and the predictive value of the model equations was reconfirmed for δ%, and the L* and b* coordinates of the CIEL*a*b* color system for different conditions of ageing in sealed vessels (90°C and 75% RH).

The framework of this study was the EU funded INVENVORG project (Thales Research Funding Program – NRSF), which investigated the natural and artificial ageing of bone, wood, textiles, parchment and paper **[29]**.

II. Related work

Whatman no 2 filter paper was used for the production of test strips, which has been used to model pure cellulose, since it consists of pure cotton cellulose with no additives, fillers or sizing[1]. Their size (7.6 X 6.5cm) was determined by the requirements of the determination of the tearing resistance.

Thirty test strips were sealed in each of seven 3-liter glass jars equipped with a sealing spring and a silicon rubber ring, containing 150 ml of saturated solution of NaCl for the adjustment of the RH at 76% ±1% **[30]**. The jars were placed in an oven at 90 ±1 °C, in which they remained for 20, 40, 60, 80, 100, 120 and 140 days. The test strips were suspended with linen thread from the lid of the jar.

For the determination of the Tearing Resistance (TR), an Elmendorf instrument (Lorentzen and Wettre) was used. At least 10 measurements for each withdrawal time were performed. The samples were preconditioned and conditioned before the TR determination according to TAPPI T 402 om-88 **[31]** standard (23°C and 25% RH for 24 hours and 23±1°C and 50±2% RH respectively).

The color coordinates L* and b* of the CIEL*a*b* color system were determined by a Dr. Lange spectrocolor LMG 183 colorimeter. Five measurements were taken for every test strip at random places and the mean was calculated.

The surface pH of paper was determined by use of a flat contact electrode according to TAPPI T 529 om-04 **[32]**. Three measurements were taken at random spots of three paper strips and averaged.

The mean Degree of Polymerization (DP) was determined by viscometry, according to the ASTM D 1795-96 **[33]** standard. An Ubbelohde viscometer was kept in a thermostatic bath at 25±0.1°C, with a suitable capillary so that the efflux time was between 80-300 sec. Cellulose was dissolved in 0.5 M cupriethylenediamine hydroxide solution, manufactured by Merck. DP values were converted to δ% (percentage of broken bonds during ageing time t) by use of equation 3 **[3,21]**.

$$\delta\% = 100 \cdot \left(\frac{2}{DP_t} - \frac{2}{DP_o}\right) \qquad (3)$$

where DP_t and DP_0 are the Degree of Polymerization values at times t and 0, and δ% the percentage of broken bonds at time t.

The experimental setup utilized in the ageing experiments has been tested for possible leakage before. The experiments reported in the 2005 paper have been based on the same setup, and weight measurements of the glass jars before and after ageing indicated that there was no weight loss. The repeatability of the experimental results was tested at that time with parallel and consecutive ageing experiments, and the results obtained shown so statistically significant differences

III. Results and Discussion

The experimental (exp) and predicted (pred) values of the determined properties are presented in Table 1, together with the property evolution equation **[21]**, the values of the regression coefficients, the coefficient estimations and their standard errors.

The kinetic model of cellulose depolymerization used here **[21]** applies to the autocatalytic acid hydrolysis of cellulose in sealed vessels and can predict the evolution of several important properties of pure cellulose paper under the experimental conditions of the ageing experiment (T=90°C, RH=76%). The production of acidic species during paper ageing has been demonstrated by several researchers **[34, 35, 36, 37]** and has been verified for the experimental setup used here **[21]**. The production of acidic species is also supported by the pH values of the aged samples (table 1).

Table 1. Experimental (exp) and predicted (pred) values of the determined properties. The pH value of 2.8 is an outlier, the very low pH value resulting from probable sample contamination.

	TR (mN)		DP	δ%		L*		b*		pH
Days of ageing	TR-exp	TR-pred	DP	δ%-exp	δ%-pred	L*-exp	L*-pred	b*-exp	b*-pred	
0	692	676	1493	0	0	97.64	96.75	1.92	2.42	5.7
20	667	662	1208	0.032	0.028	95.18	95.96	3.28	2.95	5.4
40	608	631	902	0.088	0.080	94.29	94.70	4.06	3.76	5.2
60	549	564	615	0.191	0.172	92.39	92.73	5.47	5.02	4.7
80	438	416	447	0.313	0.340	90.65	89.63	6.07	6.95	4.8
100	87	92	256	0.647	0.640	84.38	84.75	10.23	9.93	**2.8**
120	87		223	0.763		83.98		10.12		3.7
140	43		182	0.965		77.33		12.47		3.4
model equation	$TR = TR_o - C(2^{kt} - 1)$			$\delta\% = C(2^{kt} - 1)$		$L^* = L^*_o - C(2^{kt} - 1)$		$b^* = b^*_o + C(2^{kt} - 1)$		
R^2	0.994			0.996		0.973		0.964		
	Estimate	Std. Error		Estimate	Std. Error	Estimate	Std. Error	Estimate	Std. Error	
P_0	676	16		-	-	96.75	0.77	2.42	0.57	
C	11.9	6.1		0.035	0.007	1.38	1.23	0.98	1.02	
k	0.025	0.020		0.043	0.003	0.033	0.011	0.031	0.013	

The model, according to the limitations set for its theoretical development, applies for values of δ% (percentage of broken bonds) below 0.6-0.7 (which corresponds to DP values around 250). At that point starts the attack on cellulose crystallites, the rate of the hydrolysis reaction drops due to stereochemical hindrance and the

[1] https://www.gelifesciences.com/en/gb/shop/whatman-laboratory-filtration/cellulose-filter-papers

model ceases to apply **[21]**. As fig. 1 indicates, the limitation discussed above is verified by the experimental data, since the reaction starts to slow down at values of δ% around 0.6% – 0.7%. According to the above, the applicability of the model was tested for the first 100 days of ageing corresponding to values of δ% < 0.7 (DP > 250). Figure 2 presents the plots of TR (Tearing resistance), δ% (percentage of broken bonds), and L* and b* coordinates of the CIEL*a*b* color system against time of ageing. The high values of the regression coefficients presented in table 1 indicate that the fit of the experimental values to the model equation is quite satisfactory.

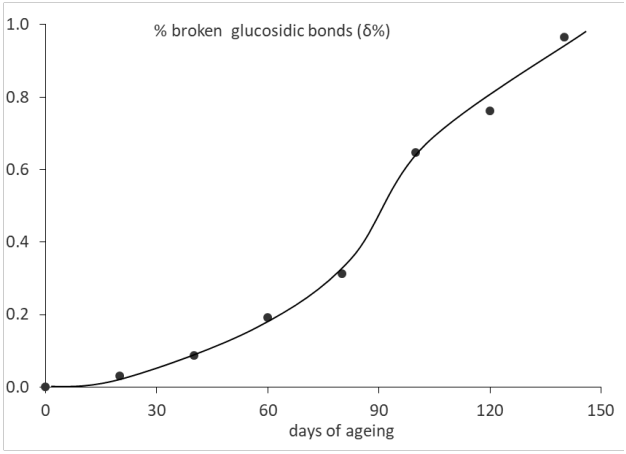

Figure 1. Plot of δ% (percentage of the broken bonds) against time

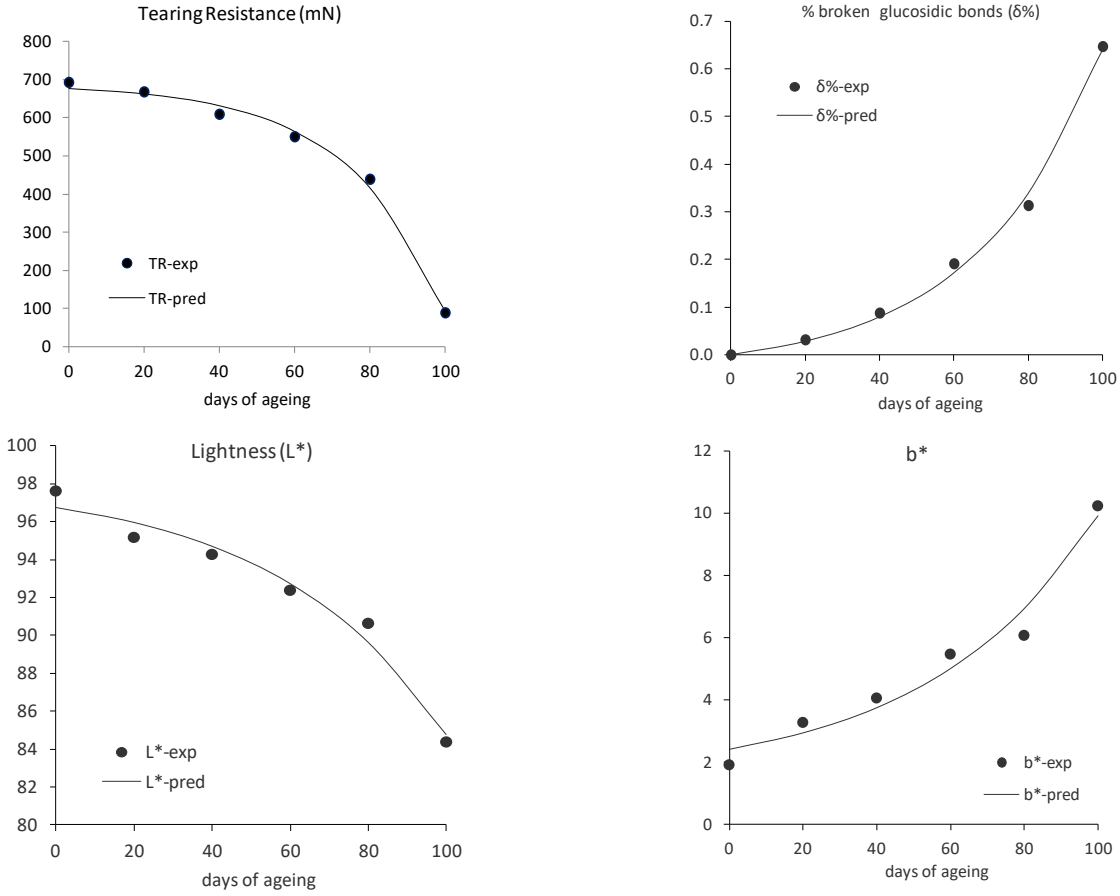

Figure 2. Plots of TR (Tearing resistance), δ% (percentage of broken bonds), and L* and b* coordinates of the CIEL*a*b* color system against time of ageing. Experimental (exp, dots) and predicted (pred, lines) values.

In the previous report, it was shown theoretically that the pH of paper under those conditions of ageing (sealed vessels, autocatalysis) drops linearly with time **([21]**, eq. 14). The fitting of the experimental values of the previous study to a linear model gave inconclusive results but worked quite well with the pH values obtained by the present study, verifying what theory predicted (fig. 3). As mentioned above, the model works until δ% approaches 0.6 - 0.7%. In many contexts, such as in paper conservation, this limitation is not important, because at that point, the mechanical properties related to the usability of paper information substrates (mainly folding endurance) drop to such low values that the paper is not usable anymore **[38]**.

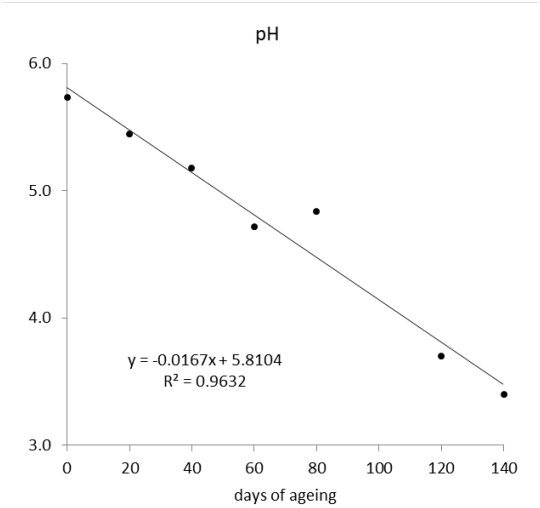

Figure 3. Surface pH of paper against time. The fit is satisfactory, as indicated by the high value of R^2. The pH value of 2.8 is an outlier (see table 1) and was not taken into account.

IV. Conclusions

Accelerated ageing in sealed vessels results in an overall deterioration of important paper properties, which accelerates with time because of the production of volatile acidic species (autocatalysis). The evolution of pure cellulose paper properties can be modeled efficiently by use of the equations presented above. In this work, it was shown that the model of autocatalytic acid hydrolysis suggested by **[21]** can be effectively applied for following the changes of tearing resistance. The applicability of the model was also verified for other paper properties, such as the percentage of broken bonds (δ%) and the L* and b* coordinates of the CIEL*a*b* color system.

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VI. References

[1] Ekenstam, A (1936). The behaviour of cellulose in mineral acid solutions. Kinetic study of the decomposition of cellulose in acid solution (Über das Verhalten der Cellulose in Mineralsäure-Lösungen, II. Mitteil.: Kinetisches Studium des Abbaus der Cellulose in Säure-Lösungen). Berichte der Deutschen Chemischen Gesellschaft 69: 553-559.

[2] Krassig, H & Kitchen, W (1961). Factors influencing tensile properties of cellulose fibers. Journal of Polymer Science 51: 123-172.

[3] Michie, RIC, Sharples, A & Walter, AA (1961). The nature of acid-sensitive linkages in cellulose. Journal of Polymer Science 51: 131-140.

[4] Fung, DPC (1969). Kinetics and mechanism of the thermal degradation of cellulose. TAPPI Journal 52(2): 319-321.

[5] Shafizadeh, F & Bradbury, AGW (1979). Thermal degradation of cellulose in air and nitrogen at low temperatures. Journal of Applied Polymer Science 23: 1431-1442.

[6] Marx-Figini, M & Coun-Matus, M (1981). On the kinetics of hydrolytic degradation of native cellulose. Die Makromolekulare Chemie 182(12): 3603-3616.

[7] Feller, RL, Lee, SB & Bogaard, J (1986). The kinetics of cellulose deterioration. In: Needles, HL & Zeronian, SH (eds.) Historic textile and paper materials. Conservation and characterization. Advances in Chemistry Series 212. Washington, DC, American Chemical Society, pp. 329-347.

[8] Fellers, C, Iversen, T, Lindstrom, T, Nilsson, T & Rigdahl, M (1989). Ageing/degradation of paper, a literature survey. FoU-projektet for papperskonservering. Stockholm, FoU-projektet for papperskonservering.

[9] Lee, SB, Bogaard, J & Feller, RL (1989). Damaging effects of visible and near-ultraviolet radiation on paper. In: Zeronian, SH & Needles, HL (eds.) Historic textile and paper materials II. Conservation and characterization. ACS Symposium Series 410. Washington, DC, American Chemical Society, pp. 54-62.

[10] Emsley, AM & Stevens, GC (1994). Kinetics and mechanisms of the low-temperature degradation of cellulose. Cellulose 1: 26-56.

[11] Zou, X, Gurnagul, N, Uesaka, T & Bouchard, J (1994). Accelerated aging of papers of pure cellulose: mechanism of cellulose degradation and paper embrittlement. Polymer Degradation and Stability 43: 393-402.

[12] Hill, DJT, Le, TT, Darveniza, M & Saha, T (1995). A study of degradation of cellulosic insulation materials in a power transformer, part 1. Molecular weight study of cellulose insulation paper. Polymer Degradation and Stability 48: 79-87.

[13] Zou, X, Uesaka, T & Gurnagul, N (1996). Prediction of paper permanence by accelerated aging I. Kinetic analysis of the aging process. Cellulose 3: 243-267.

[14] Kolar, J, Strlič, M, Malešič, J, Lemaire, J & Fromageot, D (2005). Photooxidative degradation. In: Strlič, M & Kolar, J (eds.) Ageing and stabilization of paper. Ljubljana, National and University Library, pp. 149-162.

[15] Gilbert, R, Jalbert, J, Tétreault, P, Morin, B & Denos, Y (2009). Kinetics of the production of chain-end groups and methanol from the depolymerization of cellulose during the ageing of paper/oil systems. Part 1: Standard wood kraft insulation. Cellulose 16(2): 327-338.

[16] Zervos, S (2010). Natural and accelerated ageing of cellulose and paper: A literature review. In: Lejeune, A & Deprez, T (eds.) Cellulose: Structure and Properties, Derivatives and Industrial Uses. New York, Nova Publishing, pp. 155-203.

[17] Emsley, AM, Heywood, RJ, Ali, M & Eley, CM (1997). On the Kinetics of Degradation of Cellulose. Cellulose 4: 1-5.

[18] Heywood, RJ, Stevens, GC, Ferguson, C & Emsley, AM (1999). Life assessment of cable paper using slow thermal ramp methods. Thermochimica Acta 332: 189-195.

[19] Calvini, P (2005). The influence of the leveling-off degree of polymerization on the kinetics of cellulose degradation. Cellulose 12: 445–447.

[20] Ding, H-Z & Wang, ZD (2005). Modelling the ageing of cellulose insulation in power transformers. 3rd IEE international conference on reliability of transmission and distribution networks (RTDN 2005), London, UK, IEE Conference Publication, 508: 315-319.

[21] Zervos, S & Moropoulou, A (2005). Cotton cellulose ageing in sealed vessels. Kinetic model of autocatalytic depolymerization. Cellulose 12(5): 485-496.
[22] Calvini, P & Gorassini, A (2006). On the rate of paper degradation: lessons from the past. Restaurator 27: 275–290.
[23] Calvini, P, Gorassini, A & Merlani, L (2007). Autocatalytic degradation of cellulose paper in sealed vessels. Restaurator 28(1): 47–54.
[24] Ding, H-Z & Wang, ZD (2007). Time–temperature superposition method for predicting the permanence of paper by extrapolating accelerated ageing data to ambient conditions. Cellulose 14(3): 171–181.
[25] Ding, H-Z & Wang, ZD (2008a). Author response to the comments by P. Calvini regarding the article "On the degradation evolution equations of cellulose" by H.-Z. Ding and Z. D. Wang. Cellulose 15(2): 229-237.
[26] Ding, H-Z & Wang, ZD (2008b). On the degradation evolution equations of cellulose. Cellulose 15(2): 205-224.
[27] Calvini, P (2012). The role of the Ekenstam equation on the kinetics of cellulose hydrolytic degradation. Cellulose 19(2): 313-318.
[28] Calvini, P (2014). On the meaning of the Emsley, Ding & Wang and Calvini equations applied to the degradation of cellulose. Cellulose 21(3): 1127-1134.
[29] Zervos, S, Choulis, K & Panagiaris, G (2014). Experimental design for the investigation of the environmental factors effects on organic materials (Project INVENVORG). The case of paper. Procedia - Social and Behavioral Sciences 147: 39–46.
[30] Greenspan, L (1977). Humidity fixed points of binary saturated aqueous solutions. Journal of research of the National Bureau of Standards. A, Physics and chemistry 81A (1): 89-96.
[31] TAPPI T 402 om-88 (1988). Standard conditioning and testing atmospheres for paper, board, pulp handsheets and related products.
[32] TAPPI T 529 om-04 (2004). Surface pH measurement of paper
[33] ASTM D 1795-96 (R2001). Standard test method for intrinsic viscosity of cellulose.
[34] Shahani, C, Lee, SB, Hengemihle, FH, Harrison, G, Song, P, Sierra, ML, Ryan, CC & Weberg, N (2001). Accelerated aging of paper: I. Chemical analysis of degradation products. II. Application of Arrhenius relationship. III. Proposal for a new accelerated aging test: ASTM research program into the effect of aging on printing and writing papers. Washington, DC, Library of Congress.
[35] Shahani, CJ & Harrison, G (2002). Spontaneous formation of acids in the natural aging of paper. In: Daniels, V, Donithorne, A & Smith, P (eds.) Works of Art on paper, books, documents and photographs. Techniques and conservation. Congress of the International institute for Conservation, Baltimore, MD. Int. Inst. For Conservation: 189–192.
[36] Lattuati-Derieux, A, Bonnassies-Termes, S & Lavédrine, B (2006). Characterisation of compounds emitted during natural and artificial ageing of a book. Use of headspace-solid-phase microextraction/gas chromatography/mass spectrometry. Journal of Cultural Heritage 7 123–133.
[37] Dupont, A-L, Egasse, C, Morin, A & Vasseur, F (2007). Comprehensive characterisation of cellulose- and lignocellulosedegradation products in aged papers: Capillary zone electrophoresis of low-molar mass organic acids, carbohydrates, and aromatic lignin derivatives. Carbohydrate Polymers 68 1–16.
[38] Zervos, S & Moropoulou, A (2006). Methodology and criteria for the evaluation of paper conservation interventions. Literature review. Restaurator 27(4): 219-274.

VII. AUTHORS

Prof. Spiros Zervos holds a Chemistry degree and has been trained in Paper Conservation at the Centro del bel Libro in Ascona, Switzerland. He started his professional career in 1989 working as an Archival Material Conservator at the Corfu State Archives up until April 2009, when he was elected Assistant Professor in the Department of Archival, Library and Information Studies. He teaches Conservation and Preservation of Archival and Library Materials and related topics. He obtained his PhD in material science in 2004 from the Chemical Engineering Department of the National Technical University of Athens. His research interests include paper and cellulose ageing, and conservation and preservation of paper and archival materials. Dr. Zervos is the first author and co – author of several publications - http://users.uniwa.gr/szervos/

Konstantinos Choulis studied painting and mosaic techniques at the School of Fine Arts in Athens, BA (1977-1983). With a scholarship obtained by the Hellenic Scholarship Foundation (I.K.Y.) he specialized in Paper Conservation and Restoration at the *Istituto Centrale per la patologia del libro* in Rome and in Greek Palaeography at the *Scuola di Paleografia, Diplomatica e Archivistica,* Vatican City, MA (1984 -1985). He worked as Researcher in the Vatican Library on the Greek Byzantine bookbindings, supported by the Italian Institute of Culture in Athens (1986 - 1988). He obtained the PhD in the History of the Book, University of London, School of Advanced Study (2013). Since 1994 he has been teaching Book and Paper Conservation at the Department of Conservation of Antiquities and Works of Art of the former Technological Institute of Athens, now University of West Attica. He worked as Fellow Researcher at the Istituto Centrale per la Patologia del Libro in the project "Census of Medieval Bookbindings in Italian Libraries" (Rome, 1988-1992), as Senior Lecturer in the History of Early Bookbinding Techniques at the *Scuola Europea di formazione specialistica per conservatori - restauratori di Beni Librari*, Spoleto (Italy, 1992-2003), as Visiting consultant in the Grabar Institute (Moscow, 2008-2009) for the restoration of two Greek bookbindings (Synodal Gr. 407 and Khludov Psalter) and as visiting Professor in the summer courses (1 month) organized by the International Institute for Restoration and Preservation Studies (IIRPS) in San Gemini (Italy, 2011-2017). He is the author and co-author of numerous articles and monographies in the field of the conservation of manuscripts, bookbindings and works of art on paper.

George Panagiaris is Biologist, Doctor of Biological Sciences and licensed by the Greek Ministry of Culture as Conservator of Organic Materials. He is Professor at the Department of Conservation of Antiquities and Works of Art, University of West Attica, and Head of the same Department. He is a member of the ICOM Conservation Committee with active participation in working groups dealing with collections of Natural History and Ethics Issues. His scientific / research activity focuses on issues of Conservation of Organic Materials with emphasis on human remains and collections of Natural History, issues of Biodeterioration in museum collections and on their ethical management. He has authored or coauthored over 150 publications. He has participated as main researcher or Coordinator in more than 40 Greek and International programs.

A holistic, user-driven approach to the development of an innovative, open-access Educational Framework for six existing and emerging information-related literacies

Efthymiou Foteini, Dimitrios Kouis
Department of Archival, Library & Information Studies, University of West Attica, Athens,
feuthim@uniwa.gr [**ORCID:** 0000-0002-7970-0856], dkouis@uniwa.gr [**ORCID:** 0000-0002-5948-9766]

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Abstract:

Purpose - *This article discusses a holistic, user-driven approach for the development of an innovative, open-access Educational Framework that includes six emerging information-related literacies. The Educational Framework of these literacies should be based on the structural support offered by the various Information Literacy models and is addressed to educators and librarians.*

Design/methodology/approach

The proposed Educational Frameworks' possible stakeholders and partners should plan for specific activities that will lead to the achievement of three main objectives: (a) the development of a freely available Information Literacy Training Package; (b) the training of educators and librarians, in the core skills of Information Literacy, as a horizontal goal and in new literacies as vertical goals; (c) the convergence in terms of strategy, expertise and infrastructure in Information Literacy initiatives, at a co-operative and even at a transnational level.

Expected impact – *The open access dissemination of information-related literacies concerning: critical thinking regarding issues of equality and tackling the social injustices against marginalized groups in communities; making the most of peoples' multiple interactions with digital technology and media; mobile tailored learning contents are cost effective and accessible for persons with learning disabilities; freedom of expression and information, empowerment of citizens to understand the functions of media and other information providers, to critically evaluate their content, and to make informed decisions as users and producers of information and media content; understanding and production of reliable news stories and scientific papers, based on data; dissemination and fostering of the Sustainable development goals, through the lenses of Information Literacy.*

Originality/value - *The proposed Educational Framework is a conceptually, strategically, technologically and educationally pioneering endeavor in answering specific urgent demands of the current Information and Knowledge Society.*

Index Terms — Information Literacy, Critical Literacy focusing on inequalities, Digital Literacy, Mobile Literacy, Data Literacy, Media and Information Literacy, Sustainable Development Literacy, Educational Framework, Open Access, Co-operative Initiatives

I. INTRODUCTION

The advent of the Internet and the constantly evolving technologies have transformed our society in a global interconnected and information-saturated dynamic system. In this technology and information driven society, humans are faced with unprecedented challenges in all sectors of life. Undeniably, becoming an information literate human being is one of the 21st century key skills for one's well-being, especially in education, in the work-place, in civic responsibility, etc. One of the most typical definitions of Information Literacy is "*The adoption of appropriate information behavior to identify, through whatever channel or medium, information well fitted to information needs, leading to wise and ethical use of information in society*"[1].

Additionally, other existing and emerging literacies are considered vital for personal, social, professional and environmental awareness feasibility. Among them are the following six: Critical Literacy-focusing on inequalities, Digital Literacy, Mobile Literacy, Media Literacy, Data Literacy and Sustainable Development Literacy. The cultivation and dissemination of these literacies can have a meaningful impact on society.

An innovative approach to enhancing and disseminating them is to design and apply an educational framework based on the structural support that the already established models of Information Literacy offer. Adaptation to an Information Literacy model, such as SCONUL[2], ACRL[3], and others, can lead to acquisition of the ability to define the information you need, the skill to search and access this information and the competencies to critically evaluate it and to use it wisely, and to acknowledge the information's original creator.

Arguably, among those who are placed in the heart of promoting the above literacies to today's Information & Knowledge Society, are educators, in various educational environments and librarians, in different kinds of libraries. For this reason, it is crucial for them to develop these competences in order to embed and apply Information Literacy, as well as various emerging information-related literacies. The application could occur in formal or informal

[1] Information Literacy Weblog – http://information- literacy.blogspot.com/
[2] Society of College, National and University Libraries - https://www.sconul.ac.uk/
[3] Association of College and Research Libraries - http://ala.org/acrl/

educational environments and in real-life settings, regarding social, professional and environmental, as well as, active citizenship, Mass and Social Media and personal life goals. Especially librarians, need to expand further their Information Literacy skills in order to meaningfully support educators, youth and the communities they serve.

This article proposes a holistic, user-driven approach to the development of an innovative, open-access Educational Framework for six emerging information-related literacies. The Framework is based on the structural support offered by the various Information Literacy models and is addressed to educators and librarians.

II. SIX EXISTING AND EMERGING INFORMATION-RELATED LITERACIES

A. Critical Literacy focusing on inequalities

Critical Literacy (CL) is the ability to decode various texts, images and audiovisual material, contained in different types of media, and in print, digital and electronic documents, to discover any possible bias or preconceptions that the author/content creator might have incorporated **[1]**.

This is done by analyzing the messages which promote prejudiced power relationships found in media and in documents, since authors and content creators use consciously or unconsciously their social and political influence when they express themselves. By learning how to read between the lines, namely beyond the author's words or creator's works and how to examine the manner in which the author/creator has conveyed his or her ideas about society's norms, people will be able to determine whether these ideas encapsulate racial, cultural, religious, political or gender preconceptions, that otherwise go unnoticed **[2].**

The development of critical literacy skills, with a focus on inequalities, is important because when actively engaging with the content of texts, images and audiovisual material, people can become more perceptive and societally aware citizens and may avoid receiving the various messages around them without first decoding and relating them back to their own personal life experiences. Overall, critical literacy teaches people how to dispute views regarding issues of equality and how to question the power structures in their society, aiding them to tackle the social injustices against marginalized groups in their communities **[3], [4]**.

B. Digital Literacy

The spectrum of Digital Literacy (DiL) is broad, and this becomes obvious as organizations and institutions choose to highlight different aspects of it.

Jisc refers to the term "*Digital Literacies*", defining it as "*those capabilities which fit an individual for living, learning and working in a digital society*". **Jisc** employs a seven strands model where critical thinking and creativity is applied to the broad range of interactions that each one has with and via digital technologies. The seven elements of digital literacies in **Jisc** model, are depicted in a round lateral thinking interrelation and include information literacy, media literacy, communications and collaboration, career and identity management, ICT literacy, learning skills and digital scholarship **[5]**.

The British Computer Society's (**BCS**) Digital Literacy projects are exploring methods of improving three key areas, namely employability, education and society. These are reflected at six specific digital literacy qualifications, which they deliver: Computer basics, Online basics, Audio and video software, Digital media, Digital music, Digital photography and Social networking **[6]**.

A general definition of digital literacy, that denotes many aspects of its importance, has been formulated by the European Information Society : "*Digital Literacy is the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse and synthesise digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process.*" **[7]**.

C. Mobile Literacy

Mobile learning focuses on the mobility of the learner, on the ubiquitous computing, meaning wireless networks that work together with mobile devices and applications to form the infrastructure of mobile learning and on the development and evaluation of pedagogically sound educational mobile tools and contexts **[8]**.

Mobile Literacy (ML) is an emerging literacy that has not been yet conceptually defined. While it may encompass mobile learning **[9]**, it may also relate to the widespread adoption of m-devices (e.g. mobile phones, handheld computers, MP3 players, notebooks, tablets and other newly invented mobile devices and technologies), m-applications and m-interactions in all other fields of life, such as consumption, economy, science, healthcare, citizenship, etc. **[10], [11]**.

Building on ACRL's Framework of Information Literacy for Higher Education **[12]**, it is proposed that mobile literacy may incorporate all six ACRL frames (*Authority Is Constructed and Contextual, Information Creation as a Process, Information Has Value, Research as Inquiry, Scholarship as Conversation, Searching as Strategic Exploration*) and practically interrelate them with the mobility of the learner (or citizen/scientist/consumer, etc.), ubiquitous computing and reliable mobile tools and contexts, to foster information related human competences in a mobile ecosystem **[13], [14]**.

D. Data Literacy

Data Literacy (DaL) is the capacity to find, evaluate, interpret, use and present data related information in effective and ethical ways. Although it bares many resemblances to information literacy, data literacy focuses mainly on the consumption of knowledge and on the

coherent production and critical thinking about data. It encompasses statistical literacy as well as understanding how to work with large data sets, how they are produced, how to link different data sets and how to understand and portray them.

Moreover, as open data has spread worldwide, different stakeholders consider data literacy an important 21st century skill. Therefore, initiatives that actively pursue the promise of open data as a tool of wider popular empowerment become even more crucial in comparison to investments on data for expert communities only. In light of low levels of data literacy, it is domain or subject matter experts, rather than data specialists, who actively foster development of cross-sectoral linkages and establishment of shared data infrastructure. Among them librarians and educators are in the right place to promote data literacy to the median data information user **[15], [16]**.

E. Media and Information Literacy

According to IFLA[4], Media and Information Literacy (MIL) is the competence that individuals, communities, and nations need in order to effectively and efficiently "*survive and develop, make decisions, and solve problems in every facet of life –personal, social, educational, and professional".* This information is about *"themselves as well as their physical and their social environments"* and it is "*available via three processes: observation and experimentation, conversation (with other persons), and consultation (with memory institutions)*." **[17].**

Moreover, Media and Information Literacy is a significant requirement for enabling equity in access to information and knowledge and for supporting free, independent and pluralistic media and information systems. MLI acknowledges the eminent role of information and media in people's everyday lives. It is one of the most important literacies in the information era because it lies at the core of freedom of expression and information, enabling citizens to understand the functions of media and other information providers, to critically evaluate their content, and to make informed decisions as users and producers of information and media content.

More specifically, the skills that MIL can develop include: understanding the role and functions of media in democratic societies; knowing the conditions under which media can fulfil their functions; developing the ability to critically evaluate media content; enabling people to engage with media for self-expression and democratic participation; developing people's reviewing skills (including Information and Communication Technology-ICTs skills) needed to produce user-generated content **[18], [19]**.

F. Sustainable Development Literacy

Our Common Future, published by the World Commission on Environment and Development defines sustainable development as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" **[20]**.

Gradually, the global debate on sustainable development continues and is enriched with additional goals, as was done at the United Nations Summit on September 25th, 2015 in New York, where the 2030 Agenda for Sustainable Development was formally adopted, including 17 goals (SDGs), which have been applicable since January 2016 and should be implemented by 2030. It is vital that everyone is informed about the (SDGs) 2030 Agenda[5].

The goals concern zero poverty and hunger, good health and well-being, quality education, gender equality, clean water and sanitation, cheap and clean energy, decent work and economic development, flexible infrastructure development, promotion of sustainable industrialization and promotion of innovation, less inequality, sustainable cities and communities, responsible consumption and production, urgent action to combat climate change and its impacts on sustainability and sustainable use of life on land, in peace, justice and strong institutions. However, the emphasis is on revitalizing global cooperation for sustainable development, with the aim of alleviating global barriers to generalized geopolitical and economic competition, as well as to individualism **[21]**.

Innovative initiatives and pedagogies are required in order to design and implement actions and educational frameworks for sustainable development. It is important that the above should encourage learners to develop Sustainable Development Literacy (SDL) through critical reflection and experiential practices based on the fundamental Information literacy skills of discovering, evaluating, communicating, participating/acting **[22]**.

III. Proposal for an Educational Framework for six Information-related Literacies

The Educational Framework for the six aforementioned literacies proposes innovative approaches and digital technologies for teaching and learning. More specifically, it suggests the design, test and application of various teaching models and practices, which derive from already established learning theories (e.g. behaviorism, cognitivism, constructivism, gamification, connectivism, etc.) **[23]** and can be applied in different educational technologies (Virtual Learning Environments -VLEs, Open Educational Resources-OERs, media, social networks, etc.) **[24]**. Moreover, it proposes a transnational, co-operative, continuous and open access strategy in the development, dissemination, implementation, evaluation, re-usability and update of an Information Literacy Training Package (ILTP). The ILTP should be designed in ways that can support end-users, namely

[4] International Federation of Library Associations and Institutions - https://www.ifla.org/

[5] Sustainable Development Goals Knowledge Platform - https://sustainabledevelopment.un.org/post2015/transformingourworld

educators and librarians, in developing their own practice every time they transfer the e-content and the training approaches of the ILTP, in order to tailor them to the needs of their own communities.

The proposed Framework is a conceptually, strategically, technologically and educationally pioneering endeavor in answering specific urgent demands of the current Information and Knowledge Society (see Figure 1).

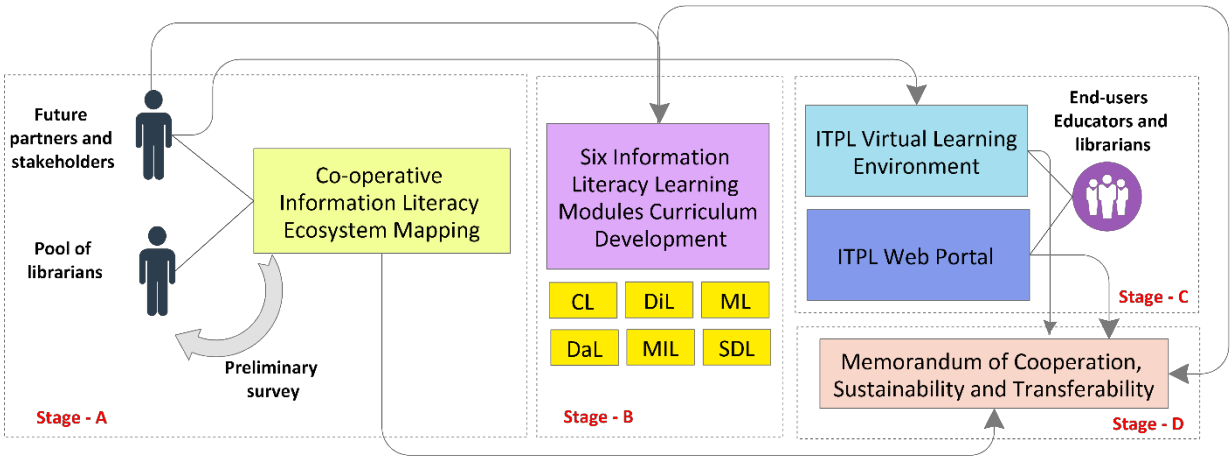

Figure 1. Overview of the Educational Framework for six Information related Literacies

At a conceptual level, the Framework is innovative as it is unique in recommending the implementation of training programmes for New Literacies (Critical Literacy-focused on inequalities, Digital Literacy, Mobile Literacy, Media and Information Literacy, Data Literacy, Sustainability Literacy), especially within a horizontal framework underpinned by the core structural skills of Information Literacy.

At a strategic level, the Framework fosters innovation by proposing the dynamic development, establishment and dissemination of New Literacies, based on the structural support of Information Literacy models, firstly among a core number of stakeholders and in the future, at a wider even transnational level. It should be based on a mutually beneficial memorandum of cooperation, sustainability and transferability between all parties. Furthermore, the Framework should be dynamic and on-going because it suggests that the participants, the multipliers and the end-users will be adding new content and learning/teaching approaches/techniques to embed pertinent material and to develop their own practices to serve their local communities.

At a technological level, the Framework should employ the use of advanced, open source and freely available VLEs, e-content, OPRs, materials, documents and media, in inventive ways. Respectively, at an educational level, the ILTP learning modules should be designed, implemented and evaluated based on new teaching models and approaches, that can derive from the bidirectional convergence between the already established aforementioned learning theories and the constantly emerging educational technologies. Therefore, the ILTP should generate quality, efficient, innovative, sophisticated, interactive and tailored-to-the need of trainees' outputs.

IV. Basic Methodology for the Implementation of the Educational Framework

This Educational Frameworks' possible stakeholders and partners should plan for specific activities that will lead to the achievement of three main objectives: (a) the development of a freely available Information Literacy Training Package; (b) the training of educators and librarians, in the core skills of Information Literacy, as a horizontal goal and in existing and new literacies as vertical goals; (c) the convergence in terms of strategy, expertise and infrastructure in Information Literacy initiatives, at a co-operative and even at a transnational level.

Specific interrelated tasks that should be assigned to future partners and stakeholders concern the following four actions which should lead to the objectives' deliverables.

A. Co-operative Information Literacy Ecosystem Mapping

In the preparatory stage, future partners and stakeholders, should distribute the six different information-related literacies described in this Framework, according to their expertise and availability, in order to undertake a relevant literature review that will capture and map the state of research for these literacies. One of the partners should be appointed as the leader of this action and each other partner should be submitting an intermediate report of their progress, while their final obligation will be to submit a complete mapping report to the leading partner in an arranged time.

Furthermore, the leading partner should submit to all participants a set of key features for a needs' analysis aiming at the creation of a pool of trainees, mainly educators and librarians. The needs analysis should focus on the identification of their qualifications, such as their expertise in the various subjects of the new literacies, experience in

distance learning programmes, etc. and on the identification of their various characteristics, such as specification of their learning needs, communities they serve etc. Following this, the leading partner should call all partners to create a pool of trainees, based on the above needs' analysis. The total number of trainees, namely educators in various types of education - formal, informal, non-formal - and librarians in different kinds of libraries, should be depending on each partner's specific educational and library ecosystem.

After the needs analysis completion, and the creation of the pool of trainees, the participants should submit the results to the leading partner. The leading partner should integrate all contributions into a final co-operative needs analysis report.

Additionally, the leading partner should provide to all partners a preliminary survey template aiming to the optimal development of the main components and content for the six Learning Modules curriculum, that will be included in the Information Literacy Learning Package. Both, curriculum components and content may include language, scope and importance, aim, learning objectives, content, bibliography, teaching methods-models-practices-approaches, evaluation and feedback methods, etc. The leading partner should ask the other partners for review and final approval.

Educators and librarians should participate in the preliminary survey to determine and finalize the main components and content of the curriculum for the six Learning Modules that will compile the Information Literacy Learning Package. After the survey completion, participants should submit the results to the leading partner that will integrate all contributions into a co-operative final report and the leading partner should send it back to all members for feedback, final editing and approval.

The final outcome should lead to the publication of a "Complete Co-operative Information Literacy Ecosystem Mapping" in the form of a book, compiled by each partner's specific contribution.

B. Six Information Literacy Learning Modules Curriculum Development

The aim is to design the pedagogical framework and to prepare the content for six learning modules, based on the results of the "Complete Co-operative Information Literacy Ecosystem Mapping".

The six learning modules curriculum, one for each new literacy, should also include: (1) a generic Information Literacy curriculum template, based on the established Information Literacy Models and (2) Teaching approaches/practices/methods, that derive from various learning theories.

It is proposed that each module's curriculum should be designed within the context of Information Literacy. This is an innovative conceptual approach to the curriculum design of these literacies, that will evolve them into information-related literacies. In more detail, each module will be independent, but all six modules will also form a complete Information Literacy Learning Package for educators and librarians who are interested in continuing their professional development, in the wider and in specific fields of Information Literacy.

Furthermore, the curriculum design should take into consideration various learning theories and teaching approaches, which derive from these theories, in order to offer end users, namely educators and librarians, a variety of quality educational approaches for the development of the different literacy skills, tailored in the needs of the communities that they serve. Trainees should be able to multiply Information Literacy skills both at a horizontal level and at a vertical level, depending on the field that they will choose each time, such as critical thinking with a focus to inequalities, digital, mobile and data literacies, as well as Media and sustainable development literacies.

The final outcome should lead to a complete Six Information Literacy Learning Modules Curriculum Development (SILLMCD), in the form of a text compiled by each partner's specific contribution. It is noted that each partner, including the leading partner should be in charge of the design and creation of at least one learning module, for which they will have conducted the literature review and mapping report, during the previous stage.

C. Virtual Learning Environment & Web Portal for the Information Literacy Training Package

The first objective of this output is to deliver a complete pilot ILTP embedded in an open access Virtual Learning Environment. The specific actions should concern the determination of the ILTP key features, the design and the pilot Implementation of the ILTP, as well as the evaluation of the pilot ILTP in the VLE. The ILPT should be piloted in the pool of trainees, namely educators and librarians, who will have participated in the preliminary survey.

The second objective is to develop, test, optimize and deliver a Web portal for end-users, mainly educators and librarians. The Web Portal should be a gateway and front-end for the ILTP integrated in the VLE, through which the Educational Framework's main target groups should be able to access its main outputs and content.

The two objectives may deliver an innovative outcome, as they will facilitate the integration of Information Literacy, as well as of existing and new literacies in various educational environments and real-world settings, in terms of transferability. The reason why is that end-users, namely educators and librarians will be able to freely re-use and down-load the rich content and the various features in order to serve their local communities, provided that they comply with the directions that should be contained in the Memorandum of Cooperation, Sustainability and Transferability, which follows.

D. Memorandum of Cooperation, Sustainability and Transferability

The aim of this output should be to compile and approve a memorandum of cooperation, sustainability and transferability between all partners. The memorandum should build on the outcomes of this Educational Frameworks' previous stages and it should focus on the provision of recommendations for the continuing update of the Learning Modules of the ILTP, such as copyright and open license issues, preservation and reusability of the content and download of the VLE's code, on-going creation of content and contribution to the developing Information Literacy Community, with new practices on behalf of all stakeholders and users involved, etc. The Impact as well as the innovation of this project is the establishment of common culture, strategy, expertise and infrastructure in Information Literacy initiatives, at a co-operative and even at a transnational level.

V. EXPECTED IMPACT AND CONCLUSION

The Impact of the development of a holistic, user-driven and open access Educational Framework is identified in two levels. (A) In co-operational level there should be established convergence in culture, strategy expertise and infrastructure in Information Literacy initiatives. (B) In local level, integration of IL and new literacies in various educational environments - formal, informal, non-formal - and in real world settings should result in developing, applying and disseminating the following concepts: critical thinking regarding issues of equality and tackling the social injustices against marginalized groups in communities; making the most of peoples' multiple interactions with digital technology and media; mobile tailored learning contents that have the added benefit of being cost effective and accessible for persons with learning disabilities; freedom of expression and information, empowerment of citizens to understand the functions of media and other information providers, to critically evaluate their content, and to make informed decisions as users and producers of information and media content; understanding and production of reliable news stories and scientific papers, based on data and open data; dissemination and fostering of the Goals of Sustainable development, through the lenses of Information Literacy.

REFERENCES

[1] White, Robert E., and Karyn Cooper. "What is critical literacy?" Democracy and Its Discontents. Brill Sense, 2015. 21-35.
[2] Luke, Allan. "Critical literacy: Foundational notes." Theory into practice 51.1 (2012): 4-11.
[3] DeVoogd, G. L., & McLaughlin, M. (2005). Critical literacy: Enhancing students' comprehension of text (pp. 5-10). New York, NY: Scholastic Publisher.
[4] King, Jennifer Ann. "Critical Literacy for Linguistically Diverse Students." (2015).
[5] JISC. (2014). Developing digital literacies. https://www.jisc.ac.uk/full-guide/developing-digital-literacies# (Accessed May 17, 2020)
[6] Qualification Specification for the BCS Entry Level Award in Digital Skills (ITQ) (Entry 3) Version 3.2 December 2019 - https://www.bcs.org/media/1633/digital-skills-specification.pdf (Accessed May 17, 2020)
[7] Martin, A. (2005). *DigEuLit – a European Framework for Digital Literacy: a Progress Report.* Journal of eLiteracy, 2, 130–136 http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.469.1923&rep=rep1&type=pdf (Accessed May 17, 2020)
[8] Hsinyi Peng , Yi-Ju Su , Chien Chou & Chin-Chung Tsai (2009) Ubiquitous knowledge construction: mobile learning re-defined and a conceptual framework, Innovations in Education and Teaching International, 46:2, 171-183, DOI: 10.1080/14703290902843828
[9] Yu, Y., Wang, S., & Emerson Haagen, L. (2010). Mobile Learning as a Catalyst to Global Citizenship Education in China. https://www.gcedclearinghouse.org/sites/default/files/resources/190150eng.pdf (Accessed May 17, 2020)
[10] Gera, R., Chadha, P., & Ahuja, V. (2020). Mobile app usage and adoption: a literature review. International Journal of Electronic Business, 15(2), 160–195. https://doi.org/10.1504/IJEB.2020.106546 (Accessed May 17, 2020)
[11] Shah, U. E. M., & Chiew, T. K. (2019). A Systematic Literature Review of the Pain Management Mobile Applications: Toward Building a Conceptual Model. IEEE Access, 7, 131512–131526. https://doi.org/10.1109/ACCESS.2019.2940772 (Accessed May 17, 2020)
[12] Framework for Information Literacy for Higher Education, American Library Association, February 9, 2015. http://www.ala.org/acrl/standards/ilframework (Accessed May 12, 2020) Document ID: b910a6c4-6c8a-0d44-7dbc-a5dcbd509e3f
[13] West, M., & Vosloo, S. (n.d.). UNESCO policy guidelines for mobile learning. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000219641 (Accessed May 17, 2020) (Accessed May 12, 2020)
[14] Ariew, S., Jacobs, S., Burress, T. G., & Mann, E. Z. (2019). Information Literacy and Data Literacy as Critical Thinking. https://digital.usfsp.edu/cctc/2019/full_schedule/26/ (Accessed May 17, 2020)
[15] Wan, N. (2011). Why digital literacy is important for science teaching and learning. Teaching Science: The Journal of the Australian Science Teachers Association, 57(4), 26–32. http://www.curriculum.edu.au/leader/why_digital_literacy_is_important_for_science_teac,34913.html?issueID=12610 (Accessed May 17, 2020)
[16] Reeves, T. D., & Chiang, J.-L. (2019). Effects of an asynchronous online data literacy intervention on pre-service and in-service educators' beliefs, self-efficacy, and practices. Computers & Education, 136, 13–33. https://doi.org/https://doi.org/10.1016/j.compedu.2019.03.004 (Accessed May 17, 2020)
[17] IFLA -- IFLA Media and Information Literacy Recommendations. (n.d.). Retrieved May 12, 2020, from https://www.ifla.org/publications/ifla-media-and-information-literacy-recommendations (Accessed May 17, 2020)
[18] United Nations Educational, Scientific and Cultural Organization, Grizzle, A., Tuazon, R., Akyempong, K., & Cheung, C. K. (n.d.). Media and information literacy curriculum for teachers. UNESCO.

https://unesdoc.unesco.org/ark:/48223/pf0000192971 (Accessed May 17, 2020)
[19] Media and Information Literacy – UNESCO IITE. (n.d.). Retrieved May 17, 2020, from https://iite.unesco.org/mil/
[20] Brundtland, Gro Harlem, et al. "Our common future." New York (1987): 8.
[21] Desa, U. N. "Transforming our world: The 2030 agenda for sustainable development." (2016).
[22] Melles, G., & Paixao-Barradas, S. (2019). Sustainable Design Literacy: Developing and Piloting Sulitest Design Module BT - Research into Design for a Connected World (A. Chakrabarti (Ed.); pp. 539–549). Springer Singapore. https://link.springer.com/chapter/10.1007/978-981-13-5974-3_47 (Accessed May 17, 2020)
[23] Schunk, Dale H. Learning theories an educational perspective sixth edition. Pearson, 2012.
[24] Mayes, T. and de Freitas, S. (2004) Review of e-learning theories, frameworks and models. JISC e-learning models study report. The Joint Information Systems Committee, London, UK.

Foteini Efthymiou works as a Technical and Laboratory Staff at the Department of Archival, Library and Information Studies of the University of West Attica. She holds a bachelor degree in Librarianship from the Faculty of Management and Economics of the Technological Educational Institute of Athens (1998), a Master of Arts in Librarianship from the Information School of the Faculty of Social Sciences of The University of Sheffield in UK (2005). She worked as a librarian at the NTUA Central Library from 1999 until 2019 and she was the main coordinator of the library's IL Service. Also, she worked for the implementation of the Hellenic Academic Libraries Union Catalog, its interconnection to the Central Interlibrary Loan Software & Network "Iris", and for the implementation of the HEALink "Advanced Services for Open Access Digital Libraries", from 2005 until 2013. She is a member of the Information Management Laboratory at the Department of Archival, Library & Information Studies of the University of West Attica. Her research interests include: Information & Media Literacy, Learning Theories, Bibliometrics.

Dimitris Kouis received his Diploma in Computer Engineering and Informatics from the University of Patras and his PhD from National Technical University of Athens (NTUA) in 1994 and 2004 respectively. His scientific interests include Library Networks, Digital Publishing, Scholarly Communication topics, Software development, Content Management, IT middleware platforms, meta-data modelling etc. He has been involved in several European and national projects and has published more than 30 articles in journals and conferences. Currently, he is an assistant professor at the Department of Archival, Library and Information Studies, University of West Attica

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