

International Panorama of Blended Learning in Science Education: a Systematic Review

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Abstract

Recently studies of technology on science education is mainly related to different environments and Blended Learning, combined models of online and face-to-face instruction. Therefore, the Systematic Literature Reviews are tools that provides detailed surveys and discussions methodologicals before their implementation. We carry out an sistematic review through the Parsifal® platform, a website with pre-defined operations. Were analyzed studies published in IEEE Xplore Digital Library, SciELO, Scopus and Springer Link, allowing the identification of 1996 studies, 79 selected according to the inclusion and exclusion criteria of our research. The findings presented specific contents in Virtual Learning Environment, Learning Management System, methodologies not originally used in Blended Learning were also incorporated, with predominance of quantitative analyzes and few reflections on theoretical-methodological aspects. Therefore, the motivation and the reports of the subjects involved in the actions were little considered when using the tools.

Keywords: Blended Learning; Science Teaching; Systematic Review

Panorama Internacional do Blended Learning no Ensino de Ciências: uma Revisão Sistemática

Resumo

Recentemente, os estudos de tecnologia no Ensino de Ciências estão relacionados principalmente a diferentes ambientes educativos e ao Blended Learning, modelos combinados de ensino online e presencial. Para tanto, as Revisões Sistemáticas da Literatura são ferramentas que fornecem levantamentos detalhados e discussões metodológicas antes de sua implementação. Posto isto, realizamos uma revisão sistemática através da plataforma Parsifal®, um site com operações pré-definidas. Foram analisados estudos publicados na Biblioteca Digital IEEE Xplore, SciELO, Scopus e Springer Link, permitindo a identificação de 1996 estudos, 79 selecionados de acordo com os critérios de inclusão e exclusão de nossa pesquisa. Também foram incorporados os achados apresentados conteúdos específicos em Ambiente Virtual de Aprendizagem, Sistema de Gestão da Aprendizagem e metodologias não utilizadas originalmente no Ensino Híbrido, ambas com predominância de análises quantitativas e poucas reflexões sobre aspectos teórico-metodológicos. Sendo assim, a motivação e os relatos dos sujeitos envolvidos nas ações foram pouco considerados na utilização das ferramentas.

Palabras clave: Blended Learning; Ensino de Ciências; Revisão Sistemática

Panorama internacional del Blended Learning en la enseñanza de las ciencias: una Revisión Sistemática

Resumen

Recientemente, los estudios de tecnología en la enseñanza de las ciencias se relacionan principalmente con diferentes entornos y Blended Learning, modelos combinados de instrucción en línea y presencial. Por lo tanto, las Revisiones Literarias Sistemáticas son herramientas que proporcionan encuestas detalladas y discusiones metodológicas antes de su implementación. Realizamos una revisión sistemática a través de la plataforma Parsifal®, un sitio web con operaciones predefinidas. Se analizaron estudios publicados en IEEE Xplore Digital Library, SciELO, Scopus y Springer Link, lo que permitió la identificación de 1996 estudios, 79 seleccionados según los criterios de inclusión y exclusión de nuestra investigación. Los hallazgos presentaron contenidos específicos en Entorno Virtual de Aprendizaje, Sistema de Gestión de Aprendizaje, también se incorporaron metodologías no utilizadas originalmente en Blended Learning, con predominio de análisis cuantitativos y pocas reflexiones sobre aspectos teórico-metodológicos. Por lo tanto, la motivación y los informes de los sujetos involucrados en las acciones fueron poco considerados en el uso de las herramientas.

Palabras clave: Blended Learning; Enseñanza de las Ciencias; Revisión sistemática

Panorama international de Blended Learning dans l'enseignement des sciences: une Revue Systématique

Résumé

Récemment, les études de la technologie sur l'enseignement des sciences sont principalement liées à différents environnements et Blended Learning, des modèles combinés d'enseignement en ligne et en face à face. Par conséquent, les revues de littérature systématiques sont des outils qui fournissent des enquêtes détaillées et des discussions méthodologiques avant leur mise en œuvre. Nous réalisons une revue systématique via la plateforme Parsifal®, un site internet aux opérations prédéfinies. Ont été analysées les études publiées dans IEEE Xplore Digital Library, SciELO, Scopus et Springer Link, permettant l'identification de 1996 études, 79 sélectionnées selon les critères d'inclusion et d'exclusion de notre recherche. Les résultats ont présenté des contenus spécifiques dans l'environnement d'apprentissage virtuel, le système de gestion de l'apprentissage, des méthodologies non utilisées à l'origine dans l'apprentissage mixte ont également été incorporées, avec une prédominance d'analyses quantitatives et peu de réflexions sur les aspects théoriques et méthodologiques. Par conséquent, la motivation et les rapports des sujets impliqués dans les actions ont été pris en compte lors de l'utilisation des outils.

Mots clés: Blended Learning; Enseignement des Sciences; Révision systématique

1. INTRODUCCION

Blended Learning is a teaching modality whose formal education program includes interspersed periods of online instruction and face-to-face in the classroom, distribution of content, teacher mediation and student autonomy. All these strategies in accordance with the pace of learning and control, by the students, in relation to time, place and path (Staker & Horn, 2012). The basis for this teaching modality is flexible and adapted, undergoing continuous changes in its systematization (Horn & Staker, 2015). Therefore, it is a new field of study that requires research that brings an overview of how this modality has been implemented and worked (Halverson et al., 2014).

The motivation of studies that assess the impact of technology on Science Education is related to the desire for innovative environments for teaching and learning (Sever et al., 2019; Suyatna & Rosidin, 2020). It is from these new demands, centered on students, that school spaces, even if traditional, need to be reassessed, with the need for a review and new procedures (Silva & Perez, 2012). Through the reviewing methods in scientific studies, for example, it is possible not only to carry out a survey of existing research, but also to recognize aspects that may be relevant or significant to meet these demands and, based on them, systematically structure an interpretation of what has been performed (Biembengut, 2008). Among the procedures that seek to build a perspective on the methodologies adopted in scientific studies, the

Systematic Review of Literature (SRL) brings evidence and procedures from search strategies, establishing and applying inclusion and exclusion criteria for the analysis of publications (Grant, 2009; Sampaio & Mancini, 2007). Based on this procedure, it is already possible to identify categorized learning activities, which reveal opportunities for Blended Learning environments, making it possible to contribute to knowledge about these environments in the school life of students and with scientific research aimed at education professionals (Al-Samarraie & Saeed, 2018).

Other directions that SRL promote in the field of Blended Learning is to provide information about the challenges of the online component of this model (Rasheed & Abdullah, 2020), which sometimes have procedural and technological limitations (Heck et al., 2016). Therefore, examining the content produced from educational experiences is of great value to detect the particularities of Blended Learning applied to Science Teaching.

2. METODOLOGY

This study was carried out based on the analysis and selection of articles published in the following databases: IEEE Digital Library, Scientific Electronic Library Online, SciVerse Scopus and Springer Link. From the selected works, we carried out a descriptive exploratory study, using the Systematic Literature Review as a procedure for extracting, synthesizing and analyzing information. We use the Parsifal® Platform as a tool, a website that presents pre-defined operations of Systematic Literature Reviews, whose phases are divided into: Search, Import Selection, Study Selection, Data Extraction and Data Analysis (Kitchenham & Charters, 2007).

In order to carry out this review, a planning protocol was established to search for articles in the aforementioned databases. From it, a search string was created, a procedure that connects terms and their respective synonyms through linking elements "AND" and "OR" (Kitchenham & Charters, 2007). In this way, the analysis of the articles was guided by the strategies that contemplated reports of experiences of Blended Learning in Science Teaching.

For the search phase, we used the terms ("Blended Learning" OR "B-learning" OR "Ensino Híbrido") AND ("Ensino de ciências" OR "Biología" OR "Biology" OR "Chemistry" OR "Ciências" OR "Física" OR "Physics" OR "Química" OR "Sciences" OR "Teaching Science"), articles available online are being selected.

The articles were obtained after executing the search string in the aforementioned databases, where the data were imported in BibTeX (.bib) format. Then, the data underwent a selection by inclusion and exclusion criteria (Table 1), considering the works that adopted Blended Learning in some aspect of Science Teaching in Basic Education. Therefore, studies that did not follow this procedure in the Population, Intervention, Comparison, Outcome/Outcome and Context (PICOC) of the research were not selected for analysis.

The classification of the results obtained was made into accepted, rejected and duplicate articles, each one composed of descriptions of authorship, abstract, country of origin, year of publication, continent, platform for which it was published, discipline applied, and methodology adopted. There was no minimum period for inclusion, only a restriction to September 2021, the month in which the

search was completed. For the works found, the abstracts and methodologies were initially read, making a pre-assessment based on the inclusion and exclusion criteria. Therefore, only the studies that were selected were read in full so that quantitative and qualitative analyzes could be carried out.

Table 1. Inclusion and exclusion criteria used in the selection of articles. Data organized by authors according to systematized searches

Inclusion Criteria	Exclusion Criteria
Blended Learning	duplicate study
Methodology in Science Teaching	
The study proposes models of Blended Learning	Study carried out in higher education
Study is an educational experience	The study does not involve natural sciences
Research brings aspects involving Blended Learning in Science Education	The study is a Systematic Review

3. RESULTS AND DISCUSSION

3.1. Quantitative aspects of articles analyzed

From the search sources used, 1996 studies were identified. However, considering the ability of the articles to answer at least one of the research questions, 1682 articles were rejected; another 235 studies were categorized as duplicates. Therefore, a total of 79 articles were maintained for data extraction and analysis. The SciVerse Scopus database had the largest number of publications, with 59 studies and, in second place, is Springer with 12 publications. The IEEE Digital Library and Scientific Electronic Library Online databases presented 5 and 3 publications, respectively (Table 2).

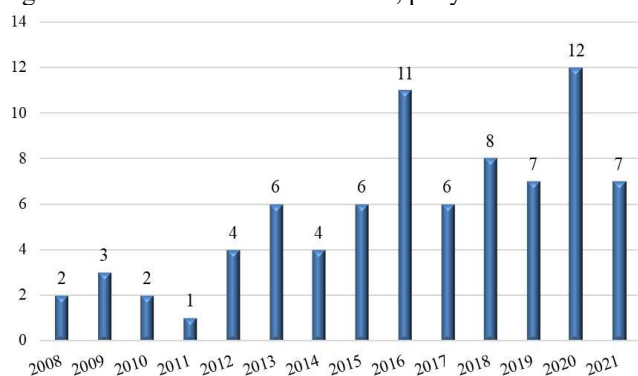
Table 2. List of articles imported and selected on the Parsifal Platform

Database	Analyzed	Duplicates	Declined	Accepted
IEEE Digital Library	186	1	180	5
Scientific Electronic Library Online	19	1	15	3
SciVerse Scopus	663	13	590	59
Springer Link	1128	220	896	12
Total	1996	235	1682	79

In to systematically organize and discuss the 79 articles, numbers from 0 to 79 were assigned to the selected publications along with their access links, their application areas and their respective authors (Annex I).

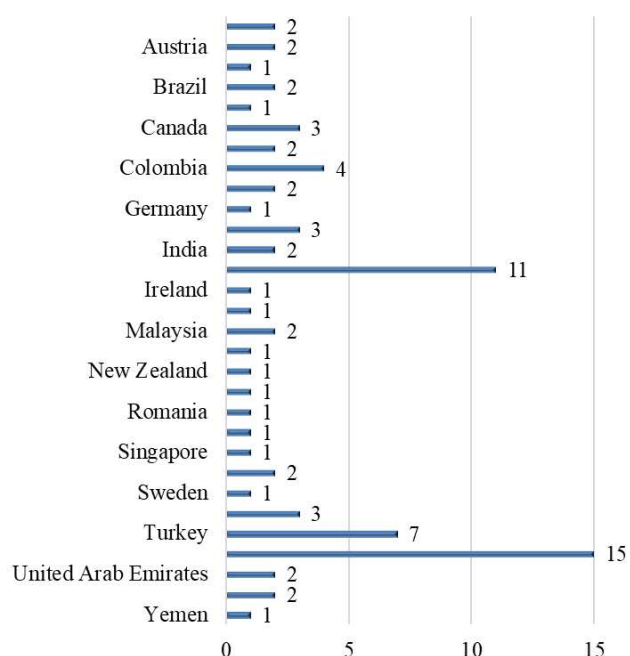
The selected articles are distributed over 14 years, covering the years 2008 to 2021. Publications do not exceed 6 articles per year until 2015, that is, only from 2016 onwards did the proportion of articles increase (Figure 1).

Figure 1. Number of selected articles, per year



Was restricted the studies by continents and respective countries (Figure 2), we have Asia leading with 29 publications, 11 of them published in Indonesia. In second place are the countries of the Americas with 25 studies, 18 of them published in North America, 15 by the United States and 3 by Canada, 6 studies in South America, 4 by Colombia and 2 by Brazil, and 1 study published in America Central, through Mexico. In the other positions were 13 studies published by Europe, 7 transcontinental studies published by Turkey, 3 studies published by Oceania and 2 studies published by joint actions between the countries of the African continent.

Figure 2. Number of studies produced by the countries



Most of the selected studies included some specific contents of Natural Sciences in High School. At this level, the contents of Physics were the most discussed, totalling 19 articles, followed by 11 articles directed to Biology and 10 articles to Chemistry. Studies contemplating joint actions of Science with Physics, used in article 21 and

Chemistry with Physics, used in article 54, were also identified. In addition to these, another 7 articles brought transversal themes of Natural Sciences. In this category, the following topics were found: Critical Science, Science and Technology, Earth Sciences, Sustainable Development, Environmental Education, Scientific Education and Rocks and Fossils, covered in articles nº 72, 66, 23, 24, 52, 3 and 25 respectively.

Other findings included hybrid methodologies through joint activities through: Teacher Training, covered exclusively by article 38; 4 actions focused on educational experiences with STEM-Science, Technology, Engineering, and Math, covered by articles 10, 49, 58 and 74; and 5 multidisciplinary activities used in articles 12, 16, 39, 60 and 71.

Despite understanding that Blended Learning actions should include classroom and distance education with online instruction (Staker & Horn, 2012), there is no model pattern among the findings. This scenario is in accordance with the definition of Blended Learning, which is under construction of meanings, without a consensus in the literature (Graham, 2005;). Therefore, we carried out the methodological discussion of the selected articles according to the identified strategies, which despite being named and discussed in some works, lacked procedural information and/or used generic terms in some publications.

3.2. Virtual Learning Environment (VLE)

The use of the term Virtual Learning Environment (VLE) is widely used in some of the selected articles, which is a generic definition for various models and digital resources aimed at learning (Dillenbourg et al., 2002). This situation is common in the terminology of e-learning systems, which have a pedagogical and technological duality, and can even be defined as Learning Management System (LMS), Course Management System (CMS), Learning Support System (LSS) and Learning Platform (LP) (Psycharis, 2013). In view of the synonym of the terms used, in the discussion of results, we assigned the term VLE to platforms that only made content available and LMS to tools that provided additional student (dis)engagement data.

Among the strategies found, the availability of information by VLE was predominant. In it, the main objective was to provide additional contents of Natural Sciences, so that students could access more activities and information outside the classroom. Therefore, the addition of digital and/or online tools during educational activities was the main concern of studies that incorporated this tool as an extension of lectures. On the other hand, studies that were committed to collecting data about student involvement in these environments showed aspects closer to the LMS, platforms that, in addition to managing and making educational materials available, support students in the learning process, including their performance (Bradley, 2021). By definition, these elements would justify the use of the term VLE in the analyzed articles, as they transcend aspects of any educational software, since the concept includes different features and behavior of its users (Dillenbourg et al., 1999).

We identified 32 LMS tools and templates pre-existing among the selected articles. Along with them, we added an

example article in which their respective procedures for the use of Blended Learning in Science Teaching can be found (Table 3).

Table 3. List of LMS tools used in selected articles

Tool/Model	Article
1. 2x2 Factorial Design	20
2. Ancova	23
3. ARCS	65
4. Arduino And Tinkercad App	19
5. Blended Learning Open Source Science Or Math Studies (BLOSSOMS)	1
6. Classroom Community Scale (CCS)	73
7. Common Knowledge (CK)	33
8. Fleming's VARK Scale	23
9. Flipped Classroom	35
10. Forum	13
11. Getsmart	21
12. Google Classroom And Schoology	66
13. Intelligent Tutor Systems	37
14. Intentional Sampling Method	10
15. Jack Electronic Assessment System	67
16. Java Applets	34
17. Learning Activity Management System (LAMS)	35
18. Massive Open Online Courses (MOOCS)	16
19. Moodle	55
20. Motivated Strategies For Learning Questionnaire (MSLQ)	41
21. Multivariate Analysis of Covariance (MANCOVA)	20
22. One-Way Anova, T-Tests And Kolmogorov Test	3
23. One-Way Multivariate Analysis Of Variance (MANOVA)	73
24. Online Learning Naturele@Rn	79
25. Plantingscience (PS)	57
26. Regression Analysis, Independent Sample T Test and Split-Plot ANOVA	61
27. Self Regulated Learning Scale (SRLS)	75
28. Technologies Self-Efficacy Scale (OTSES)	41
29. Technology Acceptance Model (TAM)	55
30. Two Way Anova	5
31. Webinars	5
32. WEBLEI	21

Besides from the pre-existing tools and models, we identified some articles that propose their own software, questionnaires, VLE and Blended Learning models. In the specially built software category, there is article 36, in the questionnaires developed by the researchers there is article

10, in the development of VLE there is article 4 and in the model proposals there are articles 39, 54, 62, 69 and 70.

Among the reports that bring the idea that the VLE goes beyond the simple delivery of content, article 17 stands out, which provides information about the control, rhythms and learning objectives in science tasks. Information was also found about the change in students' understanding of content and posture with the Moodle Learning Management System (LMS), a system adopted by the authors of article 55.

Another interesting and unique aspect among the findings was the assessment of the choice of tools by the participants in article 9, who had to choose between blogs, the VLE Moodle, email and videoconferences. From these reports, it is possible to consider that these issues presented here go beyond student performance, with VLE applications being a way of contemplating the opinions of participants in Science Education, emphasizing more the experiences with teachers and students than analyzes that are centered on pre- and post-tests.

Despite delimiting a considerable amount of VLE, which allowed identifying the function and its respective resources, we identified that a good part of the works still lack pedagogical principles, reinforcing the need for a theoretical-practical alignment so that comparative results can be made between the tools and their respective didactic intentions. In this context, an alternative presented is the importance of the constructivist social structure and cooperation, which can be implemented in the development and use of LMS (Dougiamas & Taylor, 2003). It is worth mentioning that articles 10 and 12 report remote classes and teacher training during the covid-19 pandemic as educational experiences with a view to Blended Learning. However, at no time were the students in person at the schools. But, even if they are not Blended Learning experiences among those involved, they bring contributions to its application in Science Teaching for Basic Education.

3.3. Methodologies incorporated into Blended Learning

In addition to the models and tools applicable to the VLE, 13 examples of methodologies that are not necessarily used in Blended Learning (Table 4), but which can be combined with their teaching models, were highlighted. From this observation, it is possible to infer that the term Blended Learning does justice to its etymology, since the word "blend" means mixture or fusion, while learning is formed from learned fundamentals that have the meaning of learning (Bersin, 2004).

This hybridization of methodologies within teaching is not new. Classes even before digital technologies were already mediated in a combined way by educational games, books and exercise lists (Tori, 2017) and this did not compromise in any way the pedagogical proposals presented here. On the contrary, they maintain the principles of Blended Learning, which are based on the creation of favorable environments for learning, student autonomy, virtual environments that bring instructional methods of cognitive learning to facilitate learning, support and meet the needs of the student under demand, online interaction, and learning flexibility (Bonk & Graham, 2012; Diesel et al., 2017). These incorporated methodologies demonstrated a

student learning and was implemented in the Teacher Training Course (TTC) in articles 10, 11, 19, 38, 53 and 60. As mentioned, professional development was a different strategy that composed for the Teacher Training Course (TTC). When worked together with school practice, was shown to be effective, even as a way to prepare teachers for curricular innovations (Hunzicker, 2011). This principle has been used through the Lesson Study Model (LSM) itself, which provides teachers with various professional development activities (Saito & Atencio, 2013), and which have brought satisfactory results, including during the COVID-19 pandemic, according to report the authors of article 10.

Table 4. Methodologies incorporated into Blended Learning

Built-in methodology	Article
Bloom Taxonomy	79
Collaborative Learning	33
Design-Based Search	60
Inquiry-based method	34
Kolb's experiential learning cycle	70
Lesson Study Model	10
Metacognition in Learning	40
Níveis de Guskey (2000)	53
One-To-One Scaffolding	11
Project Based Teaching	29
Self-Concept	79
Semi-Self-Directed Method	36
V-TPD (Teacher professional development)	38

The emergency situation imposed by COVID-19 required countries to quickly outline the most varied educational strategies. This intensified the search for the integration of technologies in educational environments, which need to provide teachers with flexible and accessible quality content (Sintema, 2020). At this juncture, article 19 offers a proposal that meets these two conditions. Presenting a methodological proposal and didactic resources for Blended Learning, which, although it assumes the need for a physical space for its effectiveness, observes the need to integrate these learning strategies into the continuing education of teachers. After all, broad concepts were found, most of which are examined as isolated variables, centred mainly on environments controlled by testing, with the possible contexts of formal and non-formal education being disregarded in the educational experiences lived in virtual and face-to-face environments. This profile of results has also been observed in works that focus more on instructional design, presenting few considerations in relation to the subjects of action (Halverson et al., 2014). The alternatives for these gaps presented here can be present in research that gather and discuss the results from the reports of the subjects involved in the educational experiences, be they teachers, students or parents, taking even more advantage of the potential of the Virtual Learning Environment (VLE) and the perspectives of the school community. Since its set of tools can bring together various mechanisms of communication, engagement and construction among the subjects who participate in this

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environment (Bassani & Behar, 2006). In the same way, the perspective of learning in an active way is synthesized, where knowledge is built collaboratively (Diesel et al., 2017).

4. CONCLUSION

From the analysis of the selected articles, it was possible to observe that most of the works propose to evaluate the incorporation of technology in a quantitative way, prioritizing results in grades and student engagement. Therefore, few theoretical-methodological proposals are concerned with issues related to motivation, performance and students' access to digital media, which are intrinsic to the Blended Learning implementation process. Faced with these situations, the aspects that were addressed could be better explored through reports of educational experiences, by students and teachers.

Upon becoming aware of the activities developed in the selected articles, it is possible to think about a large amount of data that could be generated from these experiences. Bearing in mind that this analysis could be a way to further integrate technology into Science Teaching, allowing to answer questions such as: Which Blended learning methodologies are most suitable for a given content? Which tools can be used in these actions? How can different sociocultural realities be met through its use?

The answer to the aforementioned questions can contribute to the alignment between technologies and methodological principles designed for Science Teaching, allowing reflections on the attitude of teachers and students. When the amount of Blended Learning works is sufficient for these discussions, we will then be able to systematize more clearly the different meanings given to this teaching model, making it possible to overcome numerical aspects of users' behaviour on teaching platforms, as well as better understand their impressions and reports of difficulty and the potential of the tools used. In this sense, the simple (dis)engagement of the students, it seems, will be better justified in contexts and peculiarities of the subjects involved.

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Annex I

Article	Autors	Knowledge area	Link of access	Abstract
1	Abd Halim et al., (2017)	Chemistry	https://tinyurl.com/2p95kyk2	Chemistry is often considered by students as a difficult subject because it has many abstract concepts which are difficult to understand. Therefore, with the advancement of technology, teaching methods have integrated multimedia elements such as video to help students to understand abstract concepts in Chemistry. Thus, the project named Blended Learning Open Source Science or Math Studies (BLOSSOMS) was introduced in 2010 by Massachusetts Institute of Technology (MIT). It is a teaching and learning method which integrates the use of video for the purpose of blended learning. BLOSSOMS allow students to actively involve in their learning either individually or in groups to solve problems raised in the video. Therefore, the aim of this study was to design cooperative learning activities in BLOSSOMS by integrating Johnson, Johnson & Smith (1991) principles and further investigated the effects towards students' achievement. "Why neutralize" was the BLOSSOMS video selected to be used in this study. It covers the neutralization concept which is a result from the reaction of acid and base. Findings showed that students' achievement increased after learning using the BLOSSOMS video. In addition, the integration of cooperative learning in the activities helped to make the learning process enjoyable for the students.
2	Acosta & Slotta (2018)	Biology	https://tinyurl.com/388y2nw6	This research paper presents the design of an active learning curriculum and corresponding software environment called CKBiology, reporting on its implementation in two sections of a Grade 12 Biology course across three design cycles. Guided by a theoretical framework called Knowledge Community and Inquiry (KCI), we employed a design-based research methodology in which we worked closely with a high school biology teacher and team of technology developers to co-design, build, test, implement, and revise this curriculum within a blended learning context. We first present the results of a needs assessment and baseline analysis in which we identify the design constraints and challenges associated with infusing a "traditional" Grade 12 Biology course with a KCI curriculum. Next, we present the design narrative for CKBiology in which we respond to these constraints and challenges, detailing the activity sequences, pedagogical aspects, and technology elements used across three design iterations. Finally, we provide a qualitative analysis of student and teacher perspectives on aspects of the design, including activity elements as well as the CKBiology interface. Findings from this analysis are synthesized into design principles which may serve the wider community of active learning researchers and practitioners.
3	Akgunduz & Akinoglu (2016)	Transversal Themes	https://tinyurl.com/mr2es83h	The main purpose of this study is to investigate the effect of blended learning and social media supported learning on the students' attitude and self-directed learning skills in Science Education. This research took place with the 7th grade 74 students attending to a primary school in Kadikoy, Istanbul and carried out "Our Body Systems" unit at 2011-2012 Academic Year. The design of the study was pretest-posttest control group design. Control Group is taught by using the traditional face to face approach with the 5E learning cycle, one of the experimental groups received blended learning model (face to face and internet based learning) with the 5E learning cycle and the other experimental group received social networking supported based on face to face approach and the 5E learning cycle model. Data were collected using the Science Teaching Attitude Scale and the Self-directed Learning Skills Scale. Quantitative data were analyzed by One-Way Anova, t-Tests and Kolmogorov Smirnov-Z Test of SPSS 17 Statistic Program. As a result, while blended learning experimental group increase science attitude and self-directed learning skills significantly than the control group; social media supported learning group has a positive impact on attitude and self-directed learning skills, although this change didn't make a significant difference compared with the control group.

- 4 Alsalhi et al., (2019) Sciences <https://tinyurl.com/232a2tj9> This study aimed to investigate the effects of blended learning on ninth grade students' achievement in science and their attitudes towards using it. It compares the results of various ways of teaching science topics, and students' attitudes towards their use. The study was conducted using a quasi-experimental design case study. The participants of the study were 112 students, divided into two groups: one an experimental group (n = 61) and the other a control group (n = 51). An achievement test and questionnaire were designed to confirm the study's validity and reliability. SPSS was used to analyze the data. The findings revealed that there were statistically significant differences between the experimental and the control groups, in favor of the experimental group, and the experimental group's attitudes were also more positive towards the using of blended learning. Their attitudes were in favor of students with academic performance in a science subject of the Performance level (Pass). The study recommends further research into the use of blended learning in higher education institutions.
- 5 Andriani et al., (2020) Biology <https://tinyurl.com/yc3cr3vs> The existence of the Covid-19 pandemic in 2020 has had a devastating impact on education. Interaction between teachers and students typically cannot be done. Based on this, innovations in education must continue to be done to improve the quality of learning. This study aimed to find out blended learning models through webinar applications and motivation on student learning outcomes in the Human Skeletal System course. The study was conducted at the Vocational High School Teachers Association of the Republic of Indonesia 2 Nganjuk Regency, East Java, Indonesia, and held in class 1 of the academic year 2019/2020 on science subjects with material on the Human Order System. The number of samples was 83 students divided into 42 experimental class students and 41 control class students. The experimental class uses the blended learning model by utilizing a webinar application, while the control class uses the help of e-modules. Data collection methods that be used are observation, questionnaires, and tests. Data analysis techniques used Two Way Anova. The results showed that (1) there were differences in student learning outcomes in the Human Skeletal System course based on the blended learning model through webinar applications, (2) there were different student learning outcomes in the Human Skeletal System course based on high learning motivation and low learning motivation, (3) there is na interaction between blended learning models through webinar applications and motivation on students' learning outcomes in the Human Skeletal System course. The novelty of this result is the application of webinars in the learning process and outcomes in the form of the holographic learning media products developed on the human skeletal system. Through holographic media, the material looks more real and resembles its original form. Students can learn skeletal systems through holographic images from a variety of different perspectives. Students are more motivated through projects given by teachers because the projects provided are engaging and able to improve skills. Students can study material both in terms of physical and biological sciences.
- 6 Applebaum et al., (2017) Sciences <https://tinyurl.com/mv2zj2t8> Physical design projects are a way to motivate and engage students in authentic science and engineering practices. Web-based tools can support design projects to ensure that students address and reflect upon critical science concepts during the course of the project. In addition, by specifying challenging design goals that require students to consider potential trade-offs between features, web-based tools may promote more deliberative scientific inquiry than open-ended or feature maximization goals. To study the role of web-supported projects, we developed an online curriculum that guides students through the planning, building, and analysis of self-propelled vehicles. To address content related to energy transformation we incorporated virtual models that display dynamic graphs of energy levels as a virtual scooter travels along a path. We compared two design goals for the project with different constraints. In the target version students are prompted to build virtual and physical scooters to reach a specific position. In the distance version students are prompted to maximize the distance the scooter travels. Our results indicate that students learned energy concepts from both versions; however, students with the target version did refer to the virtual model in their posttest responses to a greater degree than those with the distance version.

- 7 Ardianti et al., (2020) Sciences <https://tinyurl.com/2e77twz8> Educators believe that learning to utilize technology has opportunities to promote improvement in student learning performance. This optimism is undoubtedly expected to be implemented by students not only in cities but also in rural areas. The setting of this research was at the school in a rural area in Bima, Indonesia. This study explored the impact of Blended learning by using the STEM education approach on improving students' critical thinking for physics subject in secondary schools. This research was quantitative Research with pretest-posttest control group design. The experimental group was taught with blended learning that used the STEM education approach. The control group was prepared with conventional activities. Covariate in this study was prior knowledge. The dependent variable was critical thinking skills measured using an essay test. The statistical analysis used was ANCOVA which the error margin was 0.05. The research found that blended learning with STEM education approach improved better critical thinking of students than conventional learning. The limitation of this study is that during online learning, students with less digital literacy still need assistance from teachers at the beginning of learning. The contribution in this study lies in a unique framework that is in the process of delivering knowledge using blended learning embedded the STEM education approach for high school Physics lessons in the rural area.
- 8 Ardura & Zamora (2013) Physical <https://tinyurl.com/muc7a3rr> The use of virtual learning environments (VLE) is increasingly common at every stage of education. In this article, we present the results of the students' assessment of a lesson plan on Relativity implemented in Moodle at the post-compulsory level of secondary education. The assessment was carried out by means of an anonymous survey at the end of the lesson. The students achieved a high degree of satisfaction with the experience of using Moodle as a complement to classroom teaching. According to our survey results, the platform has favoured the students' self-regulation of learning.
- 9 Atici & Polat (2010) Sciences <https://tinyurl.com/57hkv222> The purpose of this study is to determine the influence of the instructional usage of the online tools on the student success and opinions in Science Education. This study, in which it tried to determine the influence of the instructional usages of the tools on the student achievement and opinions, is designed as an experimental study with the trial model. The working field of the study is composed of the eighth grade students of primary school. The sample of the study is composed of 45 primary school students having computer and internet connection. In this line, the experimental and control groups are formed from the students who are selected randomly among the students between the ranges of 300 - 350 for SBS examination grade range of the academic year of 2008-2009. Some of the findings which are obtained as a result of the study carried out qualitatively and quantitatively are as follows; it was seen that the participants took education in Test-2, that is to say, in blended learning environment between the successes of the Test-1, Test-2 and control groups. It was determined that only the students who took education in the online learning environment had more positive opinions for the online instructional tools.
- 10 Aykan & Yildirim (2021) STEM <https://tinyurl.com/2p9daap6> This paper investigated the integration of a Lesson Study Model (LSM) into distance STEM education during the COVID-19 pandemic. The study focused on six dimensions: (1) STEM education in distance learning, (2) Lesson Study (LS), (3) lesson planning processes, (4) challenges of lesson planning, (5) evaluation and assessment methods, and (6) strategies, methods, and techniques. The sample consisted of 24 science teachers recruited using criterion sampling, which is a purposive sampling method. A case study, which is a qualitative research method, was the design of choice. Data were collected through interviews, videotapes, and expert observations. The data were analyzed using inductive content analysis. Themes, categories, and codes were developed in accordance with the research purpose. Participants had positive opinions about the LSM, STEM education, and distance learning. Participants stated that the LSM activities within distance learning contributed to pedagogy and content knowledge in the STEM education process. The challenges faced by participants were unfavorable environmental conditions, time management issues, and a

lack of knowledge and experience in lesson planning. Expert observations and videotapes corroborate these results, indicating that the LSM integrated with STEM education results in higher quality STEM lesson planning and teaching. Moreover, distance learning platforms are promising ways to ensure the professional development of teachers during the pandemic.

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| 11 | Belland et al., (2015) | Sciences | https://tinyurl.com/3h6jr652 | Argumentation is central to instruction centered on socio-scientific issues (Sadler & Donnelly in International Journal of Science Education, 28(12), 1463–1488, 2006. doi:10.1080/09500690600708717). Teachers can play a big role in helping students engage in argumentation and solve authentic scientific problems. To do so, they need to learn one-to-one scaffolding—dynamic support to help students accomplish tasks that they could not complete unaided. This study explores a middle school science teacher’s provision of one-to-one scaffolding during a problem-based learning unit, in which students argued about how to optimize the water quality of their local river. The blended professional development program incorporated three 1.5-h seminars, one 8-h workshop, and 4 weeks of online education activities. Data sources were video of three small groups per period, and what students typed in response to prompts from computer-based argumentation scaffolds. Results indicated that the teacher provided one-to-one scaffolding on a par with inquiry-oriented teachers described in the literature. |
| 12 | Bergdahl & Bond (2022) | Multidisciplinary | https://tinyurl.com/y2u3b58z | It is well-recognised that engagement is critical for learning and school success. Engagement (and disengagement) are, however, also influenced by context. Thus, as digital technologies add complexity to the educational context, they influence classroom leadership, lesson designs and related practices, and thereby engagement. Despite being critical, engagement and disengagement are not well explored concerning these influences, with a lack of research undertaken within socially disadvantaged schools. In this qualitative study, 14 classroom observations were conducted, during five months, in twelve classes in an upper secondary school in Sweden, along with dialogues with teachers (n=12) and students (n=32). The data were analysed using thematic analysis and descriptive statistics. Identified themes include digital context, teacher leadership, engagement and disengagement. A network of relations between the (dis-)engagement compound and themes is presented. The results identified processes in which engagement shifted into disengagement and vice versa; in particular, that the intention of active learning does not automatically translate to active learning for all students, although teachers employed a higher work pace than did their students. Teacher self-efficacy and awareness of how to manage digital technologies in and outside the classroom was found to play a vital role in facilitating engagement. Understanding the (dis-)engagement compound in blended learning environments is key to inform active and visible learning for future research and supportive organisational structures. |
| 13 | Berger et al., (2008) | Physical | https://tinyurl.com/42etbceh | The present study examined continuity of learning between face-to-face and online environments in a “blended” professional development program designed for 16 physics teachers. The program had nine face-to-face meetings as well as continuous online exchanges between them through a website. The program focused on “knowledge integration” (KI) innovative activities in physics classes using an “evidence-based” approach: The teachers implemented the activities, collected and analyzed data about their practice and their students’ learning, and reflected on the evidence with their peers. Five reflective tools were used to promote continuity: Your Comments, Hot Polls, Smashing Sentences, Hot Reports, and Mini Research. Continuity was assessed with regard to the ideas discussed by the teachers and the reasoning patterns that they employed. Analysis of the online exchanges in relation to teachers’ face-to-face discourse revealed that the teachers discussed the same ideas (KI, evidence and learner-centered pedagogies), employed the same reasoning patterns (e.g., forming generalizations), and extended ideas in re-visitation. The online and face-to-face environments played different and complementary roles in the teachers’ learning. This study shows that appropriate use of an online environment in a blended program can lead to a continuous course of learning and can transform a “9 once-a-month-meetings” workshop into a “9-month” workshop. |

- 14 Boitshwarel o (2009) Sciences <https://tinyurl.com/2p8udar> p This paper explores a case of teacher professional development in Botswana where a blended learning solution was attempted. The analysis of the implementation environment reveals deficiencies in policy, schools (workplaces), and training providers. The paper concludes with three recommendations: 1) Schools should support ongoing teacher learning in the workplace and should manage ICT resources for use by both teachers and students; 2) Government should support participatory and localised learning and institutionalise ICT access and use; and 3) Training providers should use blended methods and should model good ICT practices. The author also notes that change is needed in the culture of teaching and learning so that ongoing, situated, participatory, and collaborative approaches are accepted. Finally, collaboration between the training providers and the schools is necessary as is a change in beliefs about the use of ICTs in education.
- 15 Boulay et al., (2013) Biology <https://tinyurl.com/5auz9vt> 5 Professional development for science teachers can be benefited through active learning in science laboratories. However, how online training materials can be used to complement traditional laboratory training is less understood. This paper explores the design of online training modules to teach molecular biology and user perception of those modules that were part of an intensive molecular biology “boot camp” targeting high school biology teachers in the State of Hawaii. The John A. Burns School of Medicine at the University of Hawaii had an opportunity to design and develop professional development that prepares science teachers with an introduction of skills, techniques, and applications for their students to conduct medical research in a laboratory setting. A group of 29 experienced teachers shared their opinions of the online materials and reported on how they used the online materials in their learning process or teaching.
- 16 Brahimí & Sarirete (2015) Multidiscipli-nary <https://tinyurl.com/m9evwt> 5h The rapid increase use of information technologies throughout educational institutions is changing the way teachers and students learn, work, and establish collaboration. The learning cycle is an ongoing process that is designed to improve the quality of, as well as collaboration among learners. Recent announcements from top Universities to turn to new forms of educational delivery called “MOOCs” (Massive Open Online Courses), have not only captured the interest of academics and students in higher education, but also the interest of students and teachers in the K-12 environment, in home schooling, or outside the classroom in general. With MOOCs, the teaching method is moving from the traditional transfer learning model where the teacher serves as the repository and transmitter of knowledge to the flipped classroom model where the learner interacts with other students, peers, and has flexible access to all information and resources around him before coming to the classroom. With the huge amount of online educational material this has become a useful and beneficial method in teaching. Speaking at the Association of Community College Trustees’ leadership meeting in Seattle, October 2013 (gatesfoundation.org), Bill Gates said “The value of MOOCs comes when you use them to create hybrids that are the best of both worlds. Rather than having the instructor lectures during class and then send the students home with assignments, many instructors are now using MOOCs to flip the classroom”. He also added “I’d be the first to say this is a period of experimentation, but we’ll learn much faster if people jump in and engage”. Hester Tinti-Kane Vice President of Marketing and Social Media Strategy, Pearson (Seaman & Tinti-Kane (2013)), said “The more we know about effective uses of technologies for teaching and learning, the faster we can adopt these new practices, facilitate their proliferation across higher education, and increase student success”. These massive open online courses which have global reach, unlimited participation, and open access over the internet via a combination of social networking and video podcasts is attracting a huge variety of students of different ages, nationalities, backgrounds, abilities, interests, etc. It’s all based on connection where you have the ability to learn, interact, and collaborate not only locally and globally but also universally from anywhere and at any time. With MOOCs providers in the USA (Coursera, edX, Udacity), Europe (FUN, Iversity), UK (FutureLearn), Middle East (Rwaq, Edraak), or in Australia

(Open2study) students can work on learning content outside of the classroom, at their own pace, and practice the application of what they learned in class. While some educators consider MOOCs as the future of higher education, others said they represent the beginning of education downfall. According to many surveys, it has been found that faculty members are not rejecting technology, in fact most of them believe in the ability of technology to bring transformative change to education but at the same time they feel that commercial considerations, rather than pedagogical considerations are driving the phenomenon of MOOCs. The objective of this study is to provide insights into recent developments of MOOCs and how they can be incorporated into high school curriculum. While it's too soon to say if MOOCs represent a substitution to traditional courses, they certainly bring a transformative change to our actual education in general and to the way our academic institutions are working. For high school for example MOOCs could be used as blended-learning approach particularly in math and science. In higher education there is a lot of excitement about MOOCs and universities are still working hard on how to use them and what impact they could have on the value of a degree. A survey has been conducted to understand how students perceive learning outside the classroom through social media, online courses, school website, and private tutoring. 310 students have been surveyed during their end of the year exams at Global International School, an international school licensed by the Saudi Arabian Ministry of Education and open to all expatriates in the Jeddah community, and accredited by the International Accreditation body "Advanced" (<http://www.advanc-ed.org/>). On the question "Learning outside the Classroom has a Positive Impact on my Education" 44.52% said they strongly agree with the statement and 51.61% said they agree while 2.58% neither agree nor disagree.

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| 17 | Burden & Kearney (2016) | Sciences | https://tinyurl.com/muj5va2n | This paper adopts scenario planning as a methodological approach and tool to help science educators reconceptualise their use of mobile technologies across various different futures. These 'futures' are set out neither as predictions nor prognoses but rather as stimuli to encourage greater discussion and reflection around the use of mobile technologies in science education. Informed by the literature and our empirical data, we consider four alternative futures for science education in a mobile world, with a particular focus on networked collaboration and student agency. We conclude that 'seamless learning', whereby students are empowered to use their mobile technologies to negotiate across physical and virtual boundaries (e.g. between school and out-of-school activities), may be the most significant factor in encouraging educators to rethink their existing pedagogical patterns, thereby realizing some of the promises of contextualised participatory science learning. |
| 18 | Castellanos & Rocha Trejo (2020) | Physical | https://tinyurl.com/24ad8e66 | This research project applied the steps of the ADDIE methodological model as the process used to implement an integrated distributed software architecture of a web system and the Moodle system, which facilitated through b-learning access to theoretical-practical study content related to the subject of Physics of Second Grade of secondary school, providing the mechanisms that simplified learning through virtual simulations of laboratory practices without physical risk or material damage, considering also that the result of the implementation would integrate the guidelines defined by the Secretary of Education Public in Mexico. The designed architecture was applied to a case study that allowed the validation of the implementation, evidencing the transfer of knowledge through an experimental group that, having a technological tool of this type, modified the teaching-learning conditions in the subject and enabled the student practice through virtual simulations any subject that was required. |
| 19 | Cavalcante & Santos (2021) | Physical | https://tinyurl.com/2sxts36r | This paper presents a methodological proposal for teaching and learning content and concepts in electricity and/or electronics integrating art, science, and culture, in a dynamic that involves the construction of 2D interactive panels anchored in the concept of interactive art in which different representations of the object occur from human interaction with the observed. Narratives are integrated into the electronic panels with the assembly and schemes prototyped in online simulators like Tinkercad, with or without programming with the Arduino. The dashboard is built to create an interface between the learner's imagination and the simulator's |

virtuality in basic electronics. Thus, we discard the purpose of learning for electronics, but learning electronics to make something that is motivating and instigating. This motivation moves the student to learning to learn and learning to do by becoming involved in electronics that makes the most sense in their lives. The learning strategies in basic electricity to build the knowledge for physical computing characterizes what we call Creative Electronics. The playful and hybrid nature of this proposed work allowed teachers to develop projects and activities that were applied in their remote classes and, according to testimonials, gained greater motivation from students. For the years 2021 and 2022 we intend to offer an Advanced Physical Computing course with a 20-hour minimum duration, focused on multiplication teachers, to give a more detailed treatment of electronics content, such as the operation of transistors and their use for the proper functioning of motors, the limits of operation of the Tinkercad simulator to study the properties of diodes, the use of integrated circuits as logic gates, among other topics brought by the teacher trainees, according to the needs of their projects and lesson plans. We expect to present these more advanced proposals in the next version of this work.

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| 20 | Çetin & Özdemir (2018) | Physical | https://tinyurl.com/v649zznv | The purpose of this study is to explore the effects of instructional mode, methods, and interaction between them. In order to achieve this purpose, two two-level-independent variables were defined, teaching modes (blended vs. face-to-face) and teaching methods (expository vs. inquiry). Thus, a 2x2 factorial design was performed with four treatment groups of 314 students. Before and after the treatments, pre-tests and posttests on achievement in electricity concepts, science process skills, and attitudes toward physics were administered. For the analysis of the data multivariate analysis of covariance were performed. It was found that the effect of blended mode is not dependent upon the teaching methods implemented. Related to the effects of instructional mode; blended instruction is more effective than face-to-face instruction in supporting students' achievement in electricity and science process skills. Additionally, it was found that the expository teaching method is as effective as the inquiry teaching method. |
| 21 | Chandra & Fisher (2009) | Science and Physics | https://tinyurl.com/2ks9zvfce | The enhanced accessibility, affordability and capability of the Internet has created enormous possibilities in terms of designing, developing and implementing innovative teaching methods in the classroom. As existing pedagogies are revamped and new ones are added, there is a need to assess the effectiveness of these approaches from the students' perspective. For more than three decades, proven qualitative and quantitative research methods associated with learning environments research have yielded productive results for educators. This article presents the findings of a study in which Getsmart, a teacher-designed website, was blended into science and physics lessons at an Australian high school. Students' perceptions of this environment were investigated, together with differences in the perceptions of students in junior and senior years of schooling. The article also explores the impact of teachers in such an environment. The investigation undertaken in this study also gave an indication of how effective Getsmart was as a teaching model in such environments. |
| 22 | Chandra & Watters (2012) | Physical | https://tinyurl.com/ycn8rdr2 | There is extensive uptake of ICT in the teaching of science but more evidence is needed on how ICT impacts on the learning practice and the learning outcomes at the classroom level. In this study, a physics website (Getsmart) was developed using the cognitive apprenticeship framework for students at a high school in Australia. This website was designed to enhance students' knowledge of concepts in physics. Reflexive pedagogies were used in the delivery learning materials in a blended learning environment. The students in the treatment group accessed the website over a 10 week period. Pre and post-test results of the treatment (N = 48) and comparison group (N = 32) were compared. The MANCOVA analysis showed that the web-based learning experience benefitted the students in the treatment group. It not only impacted on the learning outcomes, but qualitative data from the students suggested that it had a positive impact on their attitudes towards studying physics in a blended environment. |

- 23 Chen & Wang (2015) Transversal Themes <https://tinyurl.com/5c2ufs9j> Studies have proven that merging hands-on and online learning can result in an enhanced experience in learning science. In contrast to traditional online learning, multiple in-classroom activities may be involved in an augmented-reality (AR)-embedded e-learning process and thus could reduce the effects of individual differences. Using a three-stage AR-embedded instructional process, we conducted an experiment to investigate the influences of individual differences on learning earth science phenomena of “day, night, and seasons” for junior highs. The mixed-methods sequential explanatory design was employed. In the quantitative phase, factors of learning styles and ICT competences were examined alongside with the overall learning achievement. Independent t tests and ANCOVAs were employed to achieve inferential statistics. The results showed that overall learning achievement was significant for the AR-embedded instruction. Nevertheless, neither of the two learner factors exhibited significant effect on learning achievement. In the qualitative phase, we analyzed student interview records, and a wide variation on student’s preferred instructional stages were revealed. These findings could provide an alternative rationale for developing ICT-supported instruction, as our three-stage AR-embedded comprehensive e-learning scheme could enhance instruction adaptiveness to disperse the imparities of individual differences between learners.
- 24 Chin et al., (2018) Transversal Themes <https://tinyurl.com/mpp4d6u9> In the advent of digital era, the integration of technology-enhanced teacher education has been given emphasis along with raising awareness on Sustainable Development Goals (SDG). This article reports two case exemplars on the delivery of blended-mode curriculum to promote ‘Education for Sustainable Development’ (ESD) through training courses incorporating different strategies with the intention of providing students with more varieties of experiences related to learning science and mathematics. Facebook and Edmodo were used independently in different learning contexts. Students in the first case exemplar developed critical thinking skill as they justified their opinions in issues raised on Facebook. For hands-on experience, students planned and implemented various sustainability projects in primary schools. Students reported that the revised curriculum delivery strategies based on existing curriculum content helped to prepare them to teach sustainability in the future. In the second case exemplar, teachers were trained in Mathematics digital tools for teaching mathematics and subsequently employed critical thinking when they tried to make origami paper cups with the largest possible volume. In conclusion, technology-enhanced courses on sustainability should be integrated more regularly in both pre- and in-service teacher education to reaffirm the role of teacher as a vehicle of social change in sustainable development.
- 25 Chiu et al. (2017) Transversal Themes <https://tinyurl.com/339frvd m> With the rapid development of wireless networks, mobile technology and sensing technology, context-aware ubiquitous learning (u-learning), which allows anytime and anywhere learning, has been widely discussed and investigated in recent years. It has been proven by several studies that situating students to learn from the real world, such as in museums, with u-learning systems is beneficial to them. However, the traditional context-aware ubiquitous learning environment suffers from some physical limitations. For example, the capacity of the learning targets is limited, and moving time for reaching the learning targets is required. These physical limitations may affect students’ learning efficiency. To create a more efficient ubiquitous learning environment, a novel learning framework, namely blended context-aware ubiquitous learning (b-learning), is proposed in this paper. A navigation algorithm, B-MONS, is also proposed for the novel learning framework to guide students to learn efficiently in the b-learning environment. Based on the proposed b-learning framework, a blended context-aware ubiquitous learning system, BCAULS, with a navigation support mechanism based on B-MONS was designed and developed. To compare the efficacy of this new proposed framework with other learning platforms, a field experiment of the learning activity, “Rocks and Fossils,” was conducted in the National Museum of Natural Science, Taiwan. The experiment results indicate that the students performed better in the b-learning environment than in the u-learning and e-learning environments.

- 26** Coll & Coll (2018) Sciences <https://tinyurl.com/34mcautv> Background: Recent research and curriculum reforms have indicated the need for diversifying teaching approaches by drawing upon student interest and engagement in ways which makes learning science meaningful. Purpose: This study examines the integration of informal/free choice learning which occurred during learning experiences outside school (LEOS) with classroom learning using digital technologies. Specifically, the digital technologies comprised a learning management system (LMS), Moodle, which fits well with students' lived experiences and their digital world. Design and Method: This study examines three out-of-school visits to Informal Science Institutes (ISI) using a digitally integrated fieldtrip inventory (DIFI) Model. Research questions were analysed using thematic approach emerging along with semi-structured interviews, before, during and after the visit, and assessing students' learning experiences. Data comprised photographs, field notes, and unobtrusive observations of the classroom, wiki postings, student work books and teacher planning diaries. Results: We argue, that pre- and post-visit planning using the DIFI Model is more likely to engage learners, and the use of a digital learning platform was even more likely to encourage collaborative learning. The conclusion can also be drawn that students' level of motivation for collaborative learning positively correlates with their improvement in academic achievement.
- 27** Conde Hernandez et al., (2019) Physical <https://tinyurl.com/t9s9sp8> Analyze the results associated with the implementation of a Virtual Physics Laboratory, applying the Crocodile Software for the development of Competencies in Natural Sciences in the dimensions: comprehensive use of scientific knowledge, explanation of phenomena and inquiry. The results obtained from the implementation of the Virtual Physics Laboratory by applying the Crocodile Software within the Electrical Circuits Module, is a tool that, from a blended learning (blearning) environment, allows self-learning and collaborative work in students.
- 28** da Silva et al., (2021) Chemistry <https://tinyurl.com/2p8zha5c> The flipped classroom is one of the types of rotation model strategies that aim of increasing interaction and personalized contact time between students and teachers in the classroom setting. In this study, we investigated the application of the flipped classroom strategy in two classes of the different semesters in the discipline of Organic Chemistry. The teacher applied this strategy in different ways in order to verify how the flipped classroom can contribute to the teaching and learning process in the content of Nuclear Magnetic Resonance (NMR). The research, of qualitative nature, is a case study being carried out in six steps with the participation of twenty-five students and one teacher. The instruments used for data collection were an investigative questionnaire (applied to students) and a structured interview (carried out with the teacher). The results show that the students had control over their learning, presenting a favorable position for the application of the strategy. In addition, the teacher reported that it was possible to deepen the content of NMR with his students, teaching the class in a different way than he was used to, focusing on doubts (individual and collective), as well as comments regarding the materials produced by him.
- 29** Dai et al., (2021) Chemistry <https://tinyurl.com/mryes6w4> Developing students' self-study capacity is an urgent task of high schools in the current educational renovation period in Vietnam. This article presents research findings on developing self-study capacity for students through building and organizing teaching activities of 11th-grade organic chemistry project topics according to the blended learning model. The pedagogical experiment was conducted at three high schools in the north, central, and south regions of Vietnam with 125 students. The data obtained from the teacher's assessment and the students' self-assessment showed obvious development of students' self-study capacity in experimental classes.

- 30 Daley et al., (2016) Sciences <https://tinyurl.com/nzd2s6hp> Technology makes possible abundant new opportunities to capture and display data in online learning environments. We describe here an example of using these opportunities to improve students' use of the rich supports available in online learning environments. We describe an example of a blended learning experience that uses an online inquiry-based middle-school science curriculum in which we provided sixth graders (n = 126) data aligned with the Universal Design for Learning instructional framework. Students were provided and asked to reflect on their own data not only about performance but also about use of optional embedded supports vis-à-vis their perceptions of difficulty of key concepts. We determined that students were generally able to understand and interpret these rich data and that providing these data influenced subsequent help seeking in the online environment. We discuss implications for supporting help seeking and designing assessment and feedback within online learning environments.
- 31 Derlina et al., (2020) English and English-medium Physics <https://tinyurl.com/ykz6nfd4> Globalization and the emergence of IT also rendered English more relevant for second language learners. This study aims to determine the effectiveness of blended learning in improving student learning outcomes in English and physics, using augmented reality, Edmodo, and tinkercad media. This is a quasi-experimental study with data randomly obtained from 70 students of Public Senior High School (SMA) 2 on Lubuk Pakam, Indonesia. The samples were divided into two groups, each totaling 35 students. One of the classes is an experiment with blended learning, while the other is a control class comprising the conventional method. Furthermore, the research instrument consisted of a learning outcome test, in the form of an objective test administered during the pre-test and post-test in the form of an observation sheet. The effectiveness of blended learning in improving learning outcomes was analyzed using the independent sample t-test with SPSS 17. The results showed that the blended learning model effectively improves student learning outcomes through the independent and paired t-test samples of 0.148 and 0.000, significance differences, respectively. This study concludes that blended learning using augmented reality, Edmodo, and tinkercad media effectively improves student learning outcomes and can make them active
- 32 Fitriyana et al., (2020) Chemistry <https://tinyurl.com/ya3mubu> The 21st century learning system demands the use of technology in learning instruction. This research focuses on the comparison between the use of android-based-game and blended learning in the Chemistry subject on the hydrocarbon lesson toward students' self-efficacy and achievement. A quasiexperiment with post-test only design was adopted in this research. A number of 143 eleventh graders from two public senior high schools in Purworejo Regency, Indonesia were selected in a cluster random sampling as the research sample. The sample was classified into three groups depending on the media used, i.e. android-based-game only on face-to-face learning (ABG-FTFL), blended learning only (BL), and both android-based-game and blended learning (ABG-BL). Self-Efficacy Scale (SES) was used to obtain the data of students' self-efficacy while the hydrocarbon test was used to obtain students' achievement. One-way Analysis of Variance, Kruskal Wallis test, and descriptive quantity technique were performed in the data analysis, and it is found that the use of these technologies has a significant effect on the students' self-efficacy and achievement. The use of ABG-BL is better in improving students' self-efficacy while BL is better in enhancing students' achievement. Therefore, the use of android-based-game and blended learning can be emphasized as media in chemistry learning to gain better self-efficacy and achievement among students.
- 33 Fong & Slotta (2018) Sciences <https://tinyurl.com/yp34a9h6> We report on a multi-year design study of a technology environment called Common Knowledge (CK), designed to support learning communities in K-12 classrooms. Students represent their ideas in the form of notes, add their ideas to a collective knowledge base, and use this knowledge base as a resource for their subsequent inquiries. CK supports teachers' orchestration of inquiry in blended learning environments, scaffolding the learning community as it progresses through a complex inquiry script. A community knowledge base is dynamically visualized on the classroom's interactive whiteboard, serving as a persistent visual reference that allows teachers to gauge the progress of the class, identify patterns, gaps or conflicts, and engage the students in extemporaneous or

planned discussions of their ideas. We present enactments of two design iterations in which CK was integrated within broader elementary science units where the curriculum was guided by a theoretical framework called Knowledge Community and Inquiry (KCI). For each version, we analyzed the role of CK in scaffolding student inquiry, with a focus on teachers' facilitation of productive whole-class discussions. Analysis of teachers' orchestration patterns revealed a "3R" orchestration cycle (Reflect–Refocus–Release) that teachers used repeatedly within a single class session, to guide reflective community discussion and refocus students' inquiry. We also identified four distinct teacher discourse orientations, finding that these were invoked in different proportions depending on the orchestrational needs of the inquiry script. Synthesizing our findings, we discuss the role of CK within a classroom activity system for learning communities.

- 34 Garabet et al., (2012) Physical <https://tinyurl.com/3ykuanzv> Today, the Spectroscopy is not very well represented in the Romanian Physics curriculum for high school. We are trying to design a blended learning strategy to facilitate the understanding of the spectroscopic investigation phenomena. Our perspective begins with a short theoretical consideration of what light means, as for example, what is the role of the quantum transitions in the absorption and the emission of electromagnetic radiation. We are intending to use Inquiry-based method in studying Spectroscopy. So, we will try to lead the students to find the answers to the questions as the following: What is light? How is the light emitted or absorbed? What are the quantum transitions? How can we detect the emission of radiation? What is a spectrum? How can we obtain spectra with a classical spectrometer? How can we register spectra with a digital spectrometer? The students will notice the emission spectra, or pattern of wavelengths (atomic spectra) emitted by different elements in the lab. Some of the challenges will be the verification of the Lambert-Beer law and the absorption spectra of a chlorophyll solution. We are trying to find out what type of light are the green leaves using. During this kind of didactic activities we have tested the learners' satisfaction by using two questionnaires.
- 35 Gariou-Papalexiou et al., (2017) Biology <https://tinyurl.com/2p8asat9> The purpose of this study was to investigate the application of the model of the "flipped classroom" as a complementary method to school distance education in junior high school Biology. The "flipped classroom" model attempts a different way of organizing the educational process according to which the traditional methods of learning at school and studying at home are interchanged, the learners' active involvement is supported, their autonomy is reinforced, ICT is utilized and learning occurs partially by distance (blended learning). We performed an action research implementing flipped classroom in Biology teaching in a class of 17 students attending the 1st year of junior high school. The educational platform used was the Learning Activity Management System (LAMS). The findings were evaluated qualitative rather than quantitative, and can provide evidence about the prevailing situation. During the action research, it became evident that time management in the classroom was improved. Furthermore, it was observed that students' involvement in the educational process was also improved. Students had already familiarized themselves with the cognitive aspect of the lesson before entering the class and they considered the learning process as an individual affair which does not only depend on the teacher. The implementation of digital activities accomplished by distance led to taking action and initiative and finally to active learning. School distance education combined with the radical development of ICT can be complementary with the use of various methods, like the "flipped learning", and give a new perspective and potential to the limited choices of conventional education in the Greek educational system which is worth further investigation.

- 36 Garyfallidou et al., (2013) Physical <https://tinyurl.com/7996edx> How adaptable can educational software be to various teaching and learning styles? Can it easily blend into an ordinary class teaching-mode, and if so will the quality of its teaching suffer, or not? Is self-directed learning to be considered the realm of mostly older or even adult students, or could software also be used to teach more advanced students of a younger age? As a corollary, could software that was expressly designed to be utilised in an individual learning, quasi self-directed mode, be adaptable enough to yield credible educational results when used in an exhibition-mode style in class, so as to better blend with other teaching and learning methods? Is it feasible to envisage a way by which while software is used in class by the teacher to demonstrate a point, some of the gifted and specially interested pupils can access the same program online to further enhance their experience on the subject taught, acting on their own to perhaps double the rate of information delivery? These are important educational issues open for investigation, some of which the present article will attempt to start investigating, using a specially designed and proven ICT-based Science Education software. Measurements were made in which 3 groups of primary-school children participated to the total number of 166. Students' ideas on the subjects taught were measured before and after instruction using ICT. Comparative results concerning students' achievements are presented herein while testing the aforementioned software to these 10–12 year olds. Some interested results are presented herein. It seems that the most important factor is the quality of the educational software used, and not the implementation method chosen.
- 37 Gunawan (2020) Sciences <https://tinyurl.com/ycy2f4yf> Recent technological developments have increasingly supported the science learning that presents artificial intelligence as part of Internet of Things (IoT). Its implementation can be carried out through Intelligent Tutoring Systems (ITS) in blended learning environment. This technology was used to support 29 Indonesian junior secondary science teachers in creating innovative lesson plans, which are members of competencies improvement programs. The purpose of this study was to describe the lesson plans that contain an integrated science teaching, supported by ITS in blended learning. The lesson plan product was analyzed descriptively. This Qualitative method was used to determine its characteristics about curriculum integration, learning activity, technology integration, higher order thinking skills, and assessment process. The result revealed that most teachers have strongly represented aspects of these all required aspects. The lesson plan created reflects the ability of teachers who are creative and capable to integrate various contents in learning activities. Learning activities are student-centered oriented to higher-order thinking skills. Technological support applied in learning activities is also an aid for students to be more motivated, as well as the presentation of assessment aspects that are relevant to the learning objectives. There are still some inadequacies in these results to be discussed. Thus, the potential future researches for supporting the science teaching are highly welcomed.
- 38 Ho et al., (2014) Teacher training <https://tinyurl.com/3jyjdvp> The purpose of this study was to examine the effectiveness of a blended learning model on hands-on approach for in-service secondary school teachers using a quasi-experimental design. A 24-h teacher-training course using the blended learning model was administered to 117 teachers, while face-to-face instruction was given to 60 teachers. The following dependent variables were compared: degree of learners' knowledge, self-efficacy and satisfaction with the training course. The results indicated that the experimental, blended learning group showed a significantly higher level of knowledge of hands-on approach and overall satisfaction with the course. However, the self-efficacy and others items related to learner's learning satisfaction were similar between two groups. Moreover, the findings indicated that access, flexibility, cost effectiveness, improving interaction, formation of teacher network and involving of administrators, instructors and school leaders were factors which contributed to the success of blended learning model. Further implications and suggestions for the blended learning model are presented.

- 39 Huertas et al., (2015) Multidisciplinary <https://tinyurl.com/2p8nh3ms> The purpose of this study was to design and validate a computational scaffolding to foster the development of metacognitive skills in high school students. The scaffolding was intended to provide support when developing the provided content units; it allowed students to set goals and organise time and resources. It also had a mechanism to monitor and control cognitive performance so that students could adjust their learning strategies according to the task needs. A quantitative methodology with a quasi-experimental design was used, and two B-Learning courses that included units in the areas of Chemistry, English, Mathematics and Social Sciences were designed. The course prepared for the experimental group included the scaffolding and the control group did not include it. At the end of the course, the groups answered the metacognitive awareness inventory and an analysis of variance (ANOVA) was applied, the results showed significant differences in the development of metacognitive skills.
- 40 Huertas-Bustos et al., (2018) Chemistry <https://tinyurl.com/mtrhr2ed> The objective of the research was to determine the effect that a metacognitive scaffolding for Web information searches exercises on the development of school students, through a general chemistry course in a blended learning modality. One hundred and four students from a school of the city of Bogotá D.C.-Colombia participated in the study. The research followed a quasi-experimental design with a pretest and posttest. Three tenth-grade groups, previously established, worked with a b-learning environment with three versions: the first group worked with a fixed scaffolding, the second with an optional scaffolding, and the third group interacted with a b-learning environment without any type of scaffolding whatsoever. The Metacognitive Awareness Inventory (MAI) test was used to measure metacognitive abilities before and after data treatment. To analyze the data, a Multivariate Analysis of Covariance (MANCOVA) was conducted, which showed that the fixed scaffolding favors the development of metacognitive abilities, especially those related to procedural knowledge, planning, organization, monitoring, and evaluation. This tool, possibly based on the analysis and reflection of their own performance in task development, allowed students to consolidate structured strategies in Web information searches. In contrast, the use of the optional scaffolding did not exhibit the expected results since it was not used by a high percentage of students. These findings, among others, are discussed in the study.
- 41 Hwang et al., (2019) Sciences <https://tinyurl.com/26xnwa4m> Blended learning—which combines online learning with traditional face-to-face classroom instruction—is currently held in high regard. In elementary schools, science and technology education aims to help children use technology tools and to learn how disciplines such as math and science are relevant to engineering. In this study, the authors examined what type of learning profile contributes to higher achievement in science and technology in a blended learning environment. The participants consisted of 106 elementary school students (grades three to six) from two different schools. The authors adapted the Online Technologies Self-Efficacy Scale (OTSES) and the Motivated Strategies for Learning Questionnaire (MSLQ) to measure students' computer skills and learning motivation, respectively, and to understand how the blended learning environment affected their learning achievement. The results were as follows: 1) Computer skills significantly improved for all students except sixth-graders. 2) The blended learning environment had no significant effect on learning motivation. 3) In grades four and five, students in the experimental group improved more in learning achievement than students in the control group, as reflected by their higher MSLQ and OTSES scores.
- 42 Jihad (2018) Chemistry <https://tinyurl.com/mpu4e8mt> The effectiveness of blended learning was evaluated through the integration of an online chemistry platform, LabLessons. Two modules, "Formation of Hydrogen" and "Titration," were designed by college mentors alongside classroom chemistry teachers to engage and allow high school students to better comprehend these scientific topics. The pre-lab modules introduced the students to experiments they were expected to perform in class the following day. The modules consisted of an introduction as well as either a visualization and/or simulation specific to each topic. Students and teachers who utilized LabLessons were surveyed to establish a preliminary research on the use of technology in classrooms. Student and teacher surveys demonstrated LabLessons to be an interactive and helpful tool to improve students' understanding of conceptual ideas.

- 43 Kern & Crippen (2017) Sciences <https://tinyurl.com/27zzpr6f> Scientific inscriptions—graphs, diagrams, and data—and argumentation are integral to learning and communicating science and are common elements in cyberlearning environments—those involving the use of networked learning technologies. However, previous research has indicated that learners struggle to use inscriptions and when they engage in argumentation, the learning of science content becomes secondary to the learning of argumentation skills. The purpose of this study was to evaluate two scaffolding strategies for these elements in a secondary school context: (1) self-explanation prompts paired with a scientific inscription and (2) faded worked examples for the evaluation and development of scientific arguments. Participants consisted of ninth and tenth grade students (age 13–16 years; N = 245) enrolled in state-mandated biology courses taught by four different teachers. A three-factor mixed model analysis of variance with two between factors (self-explanation prompts and faded worked examples) and one within factor (pre-, post-, delayed posttest) was used to evaluate the effects on the acquisition and retention of domain-specific content knowledge. Results indicated that neither strategy influenced the acquisition and retention of science content in a positive (i.e., learning) or negative (i.e., expertise reversal effect) way. Thus, general prompts were as effective as either of the scaffolding conditions. These unanticipated results suggest that additional research is warranted for learning scaffolds with pre-college populations where the gains were established with college-aged participants.
- 44 Lohr, M. (2014) Physical <https://tinyurl.com/ywutm98p> This paper outlines the possibilities for improving the quality in physics teaching by the use of apps on iPads. In order to find out whether apps with interactive simulations, feature for displaying readouts and with augmented reality content support pupils in achieving their learning goals, the author carried out surveys among students of two classes at the BG/BRG Schwechat. iPads show their advantages in the context of blended learning sequences: the devices are instantly ready to use and allow pure haptic interaction with the content. Moreover, iPads are devices which interact with the environment: Their internal sensors and cameras allow them to “see”, “hear” and respond to physical movement and acceleration. The instant read out and visual presentation of collected data makes the iPad extremely useful for Physics teaching. Augmented reality inside and outside the classroom is not science-fiction any more.
- 45 Longo (2016) Sciences <https://tinyurl.com/msvp6xzd> Educators need to delve further into effective ways to spark student interest, motivation, and curiosity both in the middle school classroom and in the online environment. A thoughtfully crafted blended learning process, infused with inquiry learning, can provide students with opportunities to collaborate, think critically, and pose questions, both in the classroom and online. Middle school teachers can introduce this style of teaching by infusing a classroom inquiry model with the following characteristics: engagement, multiple modes of instruction, choice in activities, collaboration, and support/challenge. Despite potential barriers to this method, blended learning combined with inquiry instruction is a beneficial way to deliver instruction in multiple formats, and address the learning styles of middle school students.
- 46 Maulida et al., (2020) Physical <https://tinyurl.com/4uzk3j9e> The issue of understanding concepts in physics learning is continuing to be studied by educators, especially by utilizing information and communication technology. This study aims to reveal an increase in understanding of physics concepts with blended learning strategies integrated with guided inquiry models. The design of this study was a pre-test and post-test controlled group with the subject of research being eleventh-grade students in Yogyakarta, Indonesia. Online learning activities use EDMODO as a learning management system. Understanding the concept was measured using several 30 validated essays. Items validation aspects included subject matter, construction, and language. The statistical analysis used to determine the increase is to look at the category of gain value and T-test using alpha equal to 0.05. To avoid the other influenced factors, the numerical ability, verba knowledge were used

as covariate and those were analyzed the contribution using the linear regression. The results of this study indicate that Blended learning by integrating guided inquiry has a better impact on understanding physics concepts.

- 47 Mazowiecki -Kocyk (2021) Biology <https://tinyurl.com/z46tzcju> Conceptual teaching was developed three decades ago as an alternative to conventional teaching approaches. It promised a significant shift in teaching practices across different disciplines and age groups. Traditionally, science subjects in high school tend to be content-heavy. Teaching science, especially biology, is still rooted in teaching methods that facilitate factual understanding and low-road transfer of knowledge. As a result, students' knowledge remains compartmentalized. Students rarely make connections with other disciplines and transfer their biological knowledge to new situations. Bringing concepts to biology is a challenging task. Despite compelling evidence for concept-based teaching, there are few examples of how it can be implemented and replace content-based teaching. This article describes the changes to teaching instructions in biology over the last decade as well as the main challenges that prevent incorporating novel teaching approaches in a biology classroom. The author suggests concept-based teaching as an effective alternative to conventional, content-focused teaching and offers some ideas for implementing concepts into teaching biology in the context of blended learning.
- 48 Nagaraju & Jain (2015) Sciences <https://tinyurl.com/4xfkbckz> Burgeoning revolution in education technology has become a major factor in improving student understanding and retention of concepts. Yet, it is the fact that millions of children from economically weaker section of the society are still facing issues due to lack of quality education. This paper presents a case study on a project aimed at enhancing the Math and Science skills of primary and upper-primary school children at an NGO, which gives shelter to street children and provides them education through government schools and in-house teachers. The project is based on creating interest among children of classes 1 - 7 using technology in a blended learning model and improving learning outcome in these children. As part of the project, teachers of these homes were equipped with animated videos of short stories and practical examples, interactive applications and quizzes to teach concepts through an after school tutoring program. This study focuses on technology, design of project, its implementation and the results so far.
- 49 OH et al., (2012) STEM <https://tinyurl.com/2p8kv22u> The Educational and Career Interest scale, a self-report instrument measuring high school students' educational and career interest in STEM, was developed and validated in two studies conducted during 2010 and 2011. Study 1 included data from 92 high school students, in which exploratory factor analysis (EFA) was conducted with an initial item pool of 20 items. EFA identified three factors: educational and career interest in science, educational and career interest in technology, and educational and career interest in mathematics. Study 2 utilized data from 658 students to revisit the three-factor model using confirmative factor analysis. The two studies provide strong evidence that the scale is both valid and reliable.
- 50 Okebukola et al., (2020) Chemistry <https://tinyurl.com/45z5nuef> This paper provides glimpses of transactions in chemistry classrooms in five African countries (Burundi, Ghana, Morocco, Nigeria, and Senegal) during the COVID-19 lockdown. Members of the secondary school community in the countries including teachers, students, and school managers were unprepared for the unprecedented demand in shift from a face-to-face to an online delivery system. From a tepid, faltering start in the early days of the lockdown in Morocco, Nigeria, and Senegal, and recognizing that the end of the lockdown may not be in sight, some minuscule progress is being made in exploring virtual delivery of the chemistry curriculum. Four major challenges to online delivery of chemistry education emerged. These are a teacher capacity deficit for delivering online education, poor internet service, an erratic power supply, and severe inadequacies in infrastructure for open and distance education. Taken together along with poor teacher motivation induced by low and irregular wages, these challenges are depressants to quality chemistry teaching during the COVID-19 period. We foresee that these challenges will persist. The harsh

effect of COVID-19 on the economy of all African countries is a sign that funds will be unavailable to address these challenges in the near future. A glimmer of hope can be the reprioritization of funding resources by African governments to online delivery of education, noting that blended learning will be the new normal in the coming decades.

- 51** Oktavianti et al., (2018) Physical <https://tinyurl.com/bayz59su> This purpose of this research was to analyze the influence of blended physics learning with e-scaffolding on the gas kinetic theory to the students' scientific explanation. This research used quasi-experimentation with one group pretest-posttest design. The population of this research included the grade XI students of Natural Sciences in SMA Negeri 1 Bangkalan. The proposed hypothesis was that the blended physics learning with e-scaffolding affected the students' scientific explanation. The research results indicated that the students' scientific explanation ability significantly increased after they experienced blended physics learning with e-scaffolding. All aspects of scientific explanation, that was the claim, evidence, and reasoning improved significantly.
- 52** Oversby et al., (2019) Transversal Themes <https://tinyurl.com/2p8nx8kr> An element of social justice to be promoted through Environmental Education (EE) is that it questions some features of existing power relationships in education and community. In this paper, we describe an unusual and versatile assessment procedure supported by the blended learning platform that provides a wealth of insight into thinking. It has been trialed with secondary science students in the UK, and with STEM teacher educators in Uruguay and through Edmodo social learning platform under SEAMEO networking school project initiative. The study discovered that educators provide only a few questions, whereas younger participants provide many. We will also describe a session with Uruguayan STEM teacher educators learning to use this unusual method in their teacher training programs. In conclusion, the question generating that is proposed in this study was found to be a useful method for formative assessment both for pupils and for teachers in training especially suited when it is supported by blended learning platforms and digital tools. It provides insights into the way in which participants are thinking about a content area, giving information about the depth and security of understanding and potentially revealing misconceptions.
- 53** Owston & Wideman (2008) Mathematics, Science and Technologies <https://tinyurl.com/2ufn6dz8> **Background**
Improving the subject matter knowledge and pedagogical skills of teachers of mathematics and science is a key priority for many jurisdictions. Blended learning is a promising, yet so far seldom used model for supporting teacher professional development. This model combines the advantages of traditional face-to-face interaction with the flexibility of online learning.
Purpose
In this study, we examine two one-year professional development programs for middle-school mathematics and science/technology teachers that employed blended learning. The goal of our research was to understand how the program affected teacher attitudes toward and pedagogical practices in these subjects and on student perceptions and learning of the subjects.
Participants
Participants in the study were 68 mathematics and 65 science/technology teachers in grades 6, 7, and 8 in several school districts in a large urban center, along with their students: 477 students from the mathematics teachers' classes and 551 from the science/technology teachers' classes.
Program
The blended learning program, known as the Teacher eLearning Project (TeL), began at the start of the school year with a module that consisted of a daylong face-to-face session followed by an eight-week online session. The first year of TeL focused on the mathematics teachers who had a total of three modules to complete; in the second year, science/technology teachers had two modules.
Research design

We used Guskey's (2000) five-level evaluation framework to assess the impact of the programs on teachers' attitudes and knowledge, institutional support for the programs, changes in classroom practices, and student perceptions and learning of the subjects. Data were obtained using a pre-post design that included surveys, classroom observations, and key informant interviews.

Findings

Overall our results indicate that the program appeared to influence positively teacher attitudes and content knowledge in certain curricular areas and motivated many to transform their classroom practice to varying degrees. Despite this, student responses were mixed: students viewed mathematics less favorably by the end of the program, but became more positively inclined towards science/technology.

Conclusions

The blended learning model shows potential for teacher professional development, although further research preferably through controlled studies is needed. Aspects that need to be examined further include the nature of the online tasks given to teachers, the role of the online facilitators, the impact on student achievement, and the implications of providing teachers with less release time than was available in this study.

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| 54 | Pérez-Marín & Boza (2013) | Physics and chemistry | https://tinyurl.com/yadpjw dk | Pedagogic Conversational Agents are computer applications that can interact with students in natural language. They have been used with satisfactory results on the instruction of several domains. The authors believe that they could also be useful for the instruction of Secondary Physics and Chemistry Education. Therefore, in this paper, the authors present a procedure to create an agent for that domain. First, teachers have to introduce the exercises with their correct answers. Secondly, students will be presented the exercises, and if the students know the answer, and if it is correct, more difficult exercises will be presented. Otherwise, step-by-step natural language support will be provided to guide the student towards the solution. It is the authors' hypothesis that this innovative teaching method will be satisfactory and useful for teachers and students, and that by following the procedure more computer programmers can be encouraged to develop agents for other domains to be used by teachers and students at class. |
| 55 | Psycharis et al. (2013) | Physical | https://tinyurl.com/yckndv 8a | The purpose of this study was to investigate the role of e-learning, as a pedagogical tool, for changing initial conceptions when learning about physics by using the learning management System of the Moodle platform. Our study provides an empirical exploration of the pedagogical use of Moodle Learning Management System (LMS) in order to investigate a) the change of students' conception of fundamental issues in electricity and b) their attitudes towards the use of this LMS system. Analysis of questionnaire data shows a slight improvement in students' performance and this difference is associated with participants' conceptual understanding. Students had strong attitudes towards blended learning but this was not reflected upon their intention to further use the LMS, as expressed in responses to the TAM's questionnaire. |
| 56 | Qasem & Nathappa (2016) | Sciences | https://tinyurl.com/4njnnted | Integrating Information and Communication Technology (ICT) into teaching and learning is a growing area that has attracted many educators' efforts in recent years. The teachers need to be involved in collaborative projects and development of intervention change strategies, which would include teaching partnerships with ICT as a tool. |
| 57 | Scogin (2016) | Sciences | https://tinyurl.com/2zbjpcf u | PlantingScience is an award-winning program recognized for its innovation and use of computer-supported scientist mentoring. Science learners work on inquiry-based experiments in their classrooms and communicate asynchronously with practicing plant scientist-mentors about the projects. The purpose of this study was to identify specific factors contributing to the program's effectiveness in engaging students. Using multiple data sources, grounded theory (Strauss and Corbin in Basics of qualitative research. Sage, Newbury Park, 1990) was used to develop a conceptual model identifying the central phenomenon, causal |

conditions, intervening conditions, strategies, contexts, and student outcomes of the project. Student motivation was determined to be the central phenomenon explaining the success of the program, with student empowerment, online mentor interaction, and authenticity of the scientific experiences serving as causal conditions. Teachers contributed to student motivation by giving students more freedom, challenging students to take projects deeper, encouraging, and scaffolding. Scientists contributed to student motivation by providing explanations, asking questions, encouraging, and offering themselves as partners in the inquiry process. Several positive student outcomes of the program were uncovered and included increased positivity, greater willingness to take projects deeper, better understanding of scientific concepts, and greater commitments to collaboration. The findings of this study provide relevant information on how to develop curriculum, use technology, and train practitioners and mentors to utilize strategies and actions that improve learners' motivation to engage in authentic science in the classroom.

- 58** Seage & Türegün (2020) STEM <https://tinyurl.com/2p82njdj> Science, technology, engineering, and mathematics (STEM) programs serving students from low socioeconomic areas are understudied in the literature. More research studies need to be conducted to make informed instructional decisions for students who may be at a disadvantage compared to their peers from higher socioeconomic areas. The purpose of this research study was to determine the effects of traditional science instruction and blended learning on STEM achievement of elementary school students from low socioeconomic areas. Third, fourth and fifth grade students (N = 129) from a low-socioeconomic school were randomly assigned to receive traditional science instruction or a blended learning science curriculum approach. The science, technology, engineering, and mathematics (STEM) achievement scores were analyzed by conducting a one-way two-group Multiple Analysis of Variance (MANOVA) implemented in R statistical computing platform (R Core Team, 2018). The results indicated that the teaching method had a statistically significant effect on the linear combination of the science, technology, mathematics and engineering scores ($F(4,124) = 80.27, p < 0.0001, \text{ Pillai's Trace} = 0.721, \text{ partial } \eta^2 = 0.721$), in favor of the blended learning approach.
- 59** Shen (2016) Chemistry <https://tinyurl.com/yck4wfcu> For experimental teaching, blended learning refers to learning in a real and virtual laboratory. The integration of a real experiment and a virtual experiment, to produce blended learning in a chemistry experimente course was explored. Based on a knowledge network diagram, the blended learning activities for a Chemistry experiment course were designed covering theoretical knowledge, experimental skills and problem-solving. In this article, taking the laboratory oxygen preparation by heating potassium chlorate and manganese dioxide experiment as an example, the blended learning activities are presented and discussed.
- 60** Shin (2021) Multidisciplinary <https://tinyurl.com/4se9xnxm> This paper is a report of a design-based research project undertaken to build a blended teacher education program that focuses on cultivating teachers' competencies for personalized and blended learning in K-12 classrooms. Two iterations were designed and examined in total, with 10 teacher educators and two teacher candidate cohorts. Teacher educators collaborated with the project director to design and redesign online courses for two years, and each cohort took online teaching methods courses and trained at personalized learning schools in Texas over the course of a year. Using a mixed-methods design, teacher educators' and teacher candidates' perception data were collected and analyzed to evaluate the program's effectiveness and identify design implications and elements that inform the design and implementation of the program. The reflections and insights gained through this project offer an understanding of how blended teacher preparation can be designed to directly address the needs of K-12 schools for teachers trained in personalized and blended learning.

- 61 Siddiqui et al., (2020) Chemistry <https://tinyurl.com/4976xnup> The research study is designed to investigate the effectiveness of a blended learning program through experimental setup, where 82 (45 control sample and 37 experimental sample) students participated in the research activity. The researcher designed and applied blended learning program to enhance students' motivation towards achievements in the syllabus of O-levels Chemistry subject. Hypothesis testing achieved through regression analysis, Split Plot ANOVA, independent sample t-test and Bootstrapping for mediation. Results suggest significant and positive relationship between blended learning program, intrinsic motivation, self-efficacy, and academic achievements. Furthermore, female participants were found to be more motivated in comparison with male participants. The researcher has further discussed possible reasons for insignificant relationships among variables. It is recommended to apply training to pupils before engaging students in online learning programs. In addition, in future course of study longitudinal research design with large sample size should be adopted to develop more valid and reliable normative instruments for South Asian context.
- 62 Sivakumar & Selvakumar (2019) Physical <https://tinyurl.com/2c6pcbf> Blended Learning popularly known as B-learning is an effective integration of face-to-face and online learning/E-learning to enhance the experience and through the utilization of ICT. Blended learning combines online delivery of educational content with the best features of classroom interaction. Based on the interactions with the experienced teachers in Physics, it has been noted that the performance of the higher secondary learners in physics course is not satisfactory and needs immediate attention. To overcome this problem, an experimental study has been carried out to study the effect of blended learning package on higher secondary learners' performance and retention in physics. This study examined: post-test performance and retention performance of students in Physics when learned through blended learning and traditional lecture method. The study adopted a Quasiexperimental design. The sample was drawn from higher secondary school in Karaikudi, Sivagangai District, Tamil Nadu, India. Respondents were 40 students (21 male and 19 female). The findings revealed that: (i) there was a significant difference in the post-test scores of experimental and control groups and (ii) there was a significant difference in the retention test scores of experimental and control groups. The study concluded that Blended learning significantly improves students' achievement and retention capacity. Therefore, the study recommended that this advent of learning which combines both face to face and online delivery can effectively be utilized in learning Physics to enhance the performance and retention among higher secondary learners
- 63 Skellas et al., (2014) Sciences <https://tinyurl.com/y5wznu9h> The results of the educational trial of a Moodle-based Learning Management System (LMS), designed to assist the teaching of thermal phenomena in the Primary School, are herein presented. The Primary-School focused design of the LMS has already been described elsewhere, whereas other aspects of this study from the core of a doctoral thesis and are under publication. In this trial, 89 primary school students participated. These were divided in two roughly equivalent groups. The Experimental group was taught Heat and Thermal Phenomena utilising the new LMS, by adopting a blended learning approach and using 1 computer per student. The Control Group was taught the same using traditional teaching methods by the same teacher. The data presented herein concern only the post-tests collected three weeks after teaching, and all results presented are drawn by comparing the two groups. The results compare the two presentation approaches, namely with and without the special for Primary Education LMS, this being a pivotal part of the overall research project. This way, by not attempting to test herein either the curriculum or the educational material selected, this study focuses on the difference the LMS made to students' final understanding, thereby validating the use of LMSs in primary schools - provided the platform is suitably designed. The comparative educational effectiveness of the teaching method under consideration, i.e. using the LMS in Primary Schools, is obtained and presented. The conclusions show a marked educational advantage in the use of suitably adjusted LMS to teach Science at primary school, while pointing out to the principles to be followed for designs suitable for younger children.

- 64 Sulisworo et al., (2016) Physical <https://tinyurl.com/f59b4es3> Some research in physics teaching in secondary schools shows that cooperative learning has the potential to improve student performance. Moodle is a learning management system that has open source platform modules that can be customised according to user's needs. The purpose of this study is to figure out the effectiveness of combination between the advantages of cooperative learning and e-learning as blended learning. The research objective is to see the effect of cooperative-blended learning strategy to the learning performance on physics in high school grade XII. This research is pre-test-post-test control group design using motivation as covariate. The dependent variable is a learning strategy. The independent variable is a learning achievement. The result showed that students who were taught using cooperative learning had higher learning achievement than those taught using face-to-face learning. Motivation can be used as predictor on cooperative-blended learning. Student who had higher motivation tend to get better learning achievement.
- 65 Sulisworo et al., (2017) Physical <https://tinyurl.com/f5wa889k> The distribution of the education quality in Indonesia is relatively uneven. This affects the quality of secondary school graduates. On the other hand, the national growth of Information Communication Technology usage in Indonesia is very high, including the use of mobile technology. This is an opportunity for the application of OER (Open Educational Resources) in learning. This study aims to look at the impact of the application of the concept of blended learning OER to motivate students, especially in learning physics. The LMS used is Quipper School. This research is the quasy experimete using post test only for control group design. ARCS (Attention, Relevance, Confidence, and Satisfaction) models used in this study to observe the attention factor, relevance, confidence, and satisfaction. The analysis technique used is the analysis of variance (ANOVA). From this research, it is known that the application of the concept of OER in learning, will increase the motivation on the aspects of attention, relevance, and the confidence of the students. Meanwhile, the aspect of satisfaction on learning tends to be the same between applying the concept of OER when compared to the conventional learning face-to-face in the classroom. These findings indicate a positive impact of the application of the concept of OER in learning to student motivation.
- 66 Sulisworo et al., (2020) Transversal Themes <https://tinyurl.com/mu8tpnet> One of the characters of the globalization era is the rapid changes in various aspects of life. One of them in the advancement of science and technology, especially Information and Communication Technology (ICT) has much positive influence on the progress of education. The advantage offered not only lies in the speed factor and the ease of getting information or material resources, but some multimedia facilities can make the learning process more exciting and interactive. However, the use of this technology in learning still needs to be improved and socialized among educators. Regarding the learning problem, this study aims to see the effect of Blended learning assisted by Google Classroom and Schoology applications. The objective of this research is to implement more effective blended learning model using specific Learning Management System (LMS) to increase student learning achievement following the needs of the present era. The research design of this study was the posttest-only control group design. Two groups were given different learning. One group was as a class taught using Schoology. The other group was as a class taught using Google Classroom. The independent variable of this study is the learning strategy. The dependent variable is critical thinking skills. The instrument for measuring the critical thinking skills was problem-based question that validated the difficulty level and power of determination. The study population was students of a high school in Indonesia. The sampling technique used simple cluster random sampling. The sample in this study consisted of two classes. Testing the hypothesis of the effect of blended learning was on the results of critical thinking skills using ANOVA. From the results of this study, it can be concluded that in the case of blended learning, students who were taught to use Schoology as LMS obtained a score of critical thinking skills that were relatively higher compared to students who used Google Classroom.

- 67 Timm et al., (2020) Biology <https://tinyurl.com/3y4bnhf3> Sing two case studies from biology, the article demonstrates and analyses how domain-specific self-learning items with variable content can be generated automatically for a blended learning environment. It shows that automated item generation works well even for highly specific technical properties and that a good item quality can be produced. Evaluations are based on sample exercises from two courses in botany and genetics, each with more than 100 participants.
- 68 Trochez et al., (2016) Biology <https://tinyurl.com/yf3aery8> This paper presents the application of a framework for integrating web resources in LMS. The case study was carried out in a rural school of Cauca-Colombia. During the experience the LMS DotLRN was used to support different areas of middle school education as well as B-Learning activities. For performing the evaluation classes were given to two groups of students: one group was supported by a LMS, and in other group, the same subjects were taught conventionally. Finally academic performance and effectiveness of both approaches was analyzed.
- 69 Tsoi (2009) Sciences <https://tinyurl.com/yf3aery8> Purpose Research on the nature of blended learning and its features has led to a variety of approaches to the practice of blended learning. The purpose of this paper is to provide an alternative practice model, the TSOI hybrid learning model (HLM) to enhance the blended learning experiences in science education. Design/methodology/approach The Piagetian science learning cycle model and Kolb's experiential learning cycle model are used to structure the theoretical framework of this model. This HLM which is research evidence-based represents learning as a cognitive process in a cycle of four phases: Translating, Sculpting, Operationalizing and Integrating. A major feature is to promote active cognitive processing in the learner for meaningful and engaged learning proceeding from inductive to deductive and also addressing the learner's individual learning style. Thus, it is inclined towards constructivism. Findings the paper provides students' responses in terms of blog and wiki. Practical implications an application of this HLM to enhance blended learning experiences in science education is illustrated with an authentic example on understanding multimedia learning design in an e-learning environment for pre-service teachers. Outcomes, feedback and implications will be discussed in the context of blended learning in science education.
- 70 Tsoi (2010) Sciences <https://tinyurl.com/2as5k5jf> This paper describes a research evidence-based practice model, TSOI Hybrid Learning Model as a viable alternative to support productive integration of Web 2.0-mediated collaboration for learning. The model is advanced from the Science learning cycle and the Kolb's experiential learning cycle. An authentic example on understanding multimedia learning pedagogy for pre-service teachers in chemistry education is illustrated. The model guides the learning design involving Web 2.0-mediated collaborative activities. Outcomes in terms of richness of collaborative learning and reflections have been positive. Implications will be discussed in the context of blended learning in science education.
- 71 Varier et al., (2017) Multidisciplinary <https://tinyurl.com/ycknzty5> Increased efforts to promote 21st century learning emphasize the central role of technology in instructional delivery in order to advance the multifaceted abilities and skills required for student success in an increasingly technology-rich learning and work environment. A qualitative study was conducted in a large, economically diverse, mid-Atlantic school district to examine the implementation of six technology devices in 18 elementary, middle, and high school classrooms. The purpose was to understand teachers' and students' experiences related to the instructional implications of each device to inform long term, one-to-one implementation of an appropriate technology device to meet the district's strategic goals for a 21st century learning environment. Teacher interviews and student focus groups revealed several themes related to technology integration, factors influencing implementation, impact on instruction, and impact on student motivation and engagement. Findings are discussed in relation to the

district infrastructure and other considerations to support a one-to-one teaching and learning environment and how each of the six devices support the establishment of 21st century learning environments.

- 72 Wahyuni et al., (2019) Transversal Themes <https://tinyurl.com/52mkkyeu> This study aims to analyze students' scientific critical thinking skills through learning with edmodo-based blended learning models. This study is Pre-Experimental using one group pre-test post-test design involving 35 class VIII students at Public Junior High School 10 Jember, Indonesia. The instruments used were teacher activity observation sheets, student activity observation sheets, scientific critical thinking skills assessment sheets, and student motivation sheets. Before and after learning activity, students are given the same initial test (pre-test) and final test (post-test). The collected data was analyzed by quantitative descriptive analysis. The results of the study show that: (1) students are motivated in classical learning by 78.13% with motivated criteria. The highest value is on the likes and active indicators using Edmodo, which is equal to 88.47% and the lowest value on the indicator of activity asks questions and opinions at edmodo, which is equal to 70.93%; and (2) there is an increase in scientific critical thinking skills of students with a mean n-gain of .32, with the criteria being moderate. The highest value is achieved on the indicator of fact analysis, which is equal to .55 and the lowest value on the indicators of delivery of argumentation, which is equal to .19. The conclusion of this study is that science learning with an edmodo-based blended learning model can motivate learning and improve scientific critical thinking skills of junior high school students
- 73 Wendt & Rockinson-Szapkiw (2015) Physical <https://tinyurl.com/2p8mn882> Using a quasi-experimental, nonequivalent pretest/posttest control group design, the researchers examined the effects of online collaborative learning on eighth-grade student's sense of community in a physical science class. For a 9-week period, students in the control group participated in collaborative activities in a face-to-face learning environment, whereas students in the experimental group participated in online collaborative activities using the Edmodo educational platform in a hybrid learning environment. Students completed the Classroom Community Scale survey as a pretest and posttest. Results indicated that the students who participated in the face-to-face classroom had higher overall sense of community and learning community than students who participated in collaborative activities in the online environment. Results and implications are discussed and suggestions for future research are provided.
- 74 Wever et al., (2018) STEM <https://tinyurl.com/4e8s3vdm> Quality out-of-school time (OST) programs for youth are limited by a lack of professional learning opportunities for staff and volunteers that are based upon solid learning theory, affordable, and scalable for a diverse field. The Click2Science project is an innovative model for professional learning experiences that support staff and volunteers in providing high-quality science, technology, engineering, and math (STEM) learning opportunities for youth. This model of professional learning emphasizes the importance of visual, social, and experiential learning experiences with reflection and application to practice. The model leverages technology and in-person support in a cycle of professional development experiences. The experiences included in the professional development model allow staff and volunteers in OST programs to develop their instructional skills in ways that are embedded in the actual practices of their program. In this article, each part of the professional development cycle is analyzed using constructivist learning theories to encourage adult educators to replicate this model in other fields. A brief review of promising research about the effectiveness of the model concludes the description of this approach to professional development.
- 75 Wiyars et al., (2019) Chemistry <https://tinyurl.com/4v23zn7a> This research aimed to analyse the use of chemistry-on-android (chemondro) game and blended learning as the implementation of technology on hydrocarbon topics toward students' self-regulated learning. A comparative study has employed in this research. There were three groups of students with a total of 143 students represents from all of the eleventh graders in Purworejo Regency, Indonesia. These three groups of students applied different technology as the media on its learning process. A group which applying

'chemondro' game, a group with blended learning and the last group with the combination between the two. A Self-Regulated Learning Scale (SRLS) was administrated to obtain the data. These data of students' self-regulated learning were classified into five categories, from excellent to very poor category according to analysis based on the criteria of mean ideal and ideal standard deviation. The results of the analysis showed that the profile of students' self-regulated learning on the group that used the 'chemondro' game only as the media was better compared to the other two student groups. This research suggests that the used of educational game should be widely used in chemistry learning to promote students' self-regulated learning.

- 76 Yapici & Akbayin (2012) Biology <https://tinyurl.com/8zkxher4> In this study, it is aimed to determine the high school students' views on blended learning. The study was carried out in biology course for the lesson unit of "Classification of Living Things and Biodiversity" with 47 9th grade students attending Nevzat Ayaz Anatolian High School in the second term of the academic year of 2009-2010. The lessons were taught in a way appropriate to the blended learning model both via the Internet and on face-to-face basis. As the online dimension of the blended learning model, Moodle, a Learning Management System (LMS), was used. The application lasted 10 weeks. The scale of learners' views on blended learning was applied and interviews were held to determine the views. As a result of the analysis of the scale, it was seen that their views were "highly" positive. The interviews held with the students revealed that the blended learning model provided students with various opportunities such as getting prepared for the lessons, reviewing the lessons as many times as wanted, reaching the subject-related materials without being dependent on time and place, testing oneself and communicating with the teacher and other students out of the school. The interviews also revealed that there were various problems though such as lack of Internet connection at home and problems experienced while playing the videos.
- 77 Yapici & Akbayin (2012) Biology <https://tinyurl.com/44wr5uv7> The present study aims to determine the effect of the blended learning model on high school students' biology achievement and on their attitudes towards the Internet. Among the experimental models, the pretest-posttest control group model was used in the study. The study was carried out with 107 students (47 of whom were in the experimental group, and 60 of whom were in the control group) attending Nevzat Ayaz Anatolian High School in Diyarbakir in Spring Term of the academic year of 2009-2010. In the experimental group, the courses were taught based on the blended learning model via a website (www.e-biyoloji.net), while in the control group, the courses were taught based on traditional teaching methods. An Internet Attitude Scale [image omitted] =0,97) and an achievement test of 40 questions (KR-20=0.88) were used as the data collection tools. For the analysis of the data, mean scores, independent t-test and paired samples t-test were used. The research results revealed that the blended learning model contributed more to the students' biology achievement than traditional teaching methods did and that the students' attitudes towards the Internet developed statistically significantly.
- 78 Yapici & Akbayin (2013) Biology <https://tinyurl.com/4krb6fzn> The present study aimed at evaluating the application of the blended learning method in biology teaching as well as the results of the application of this method. For this purpose, the effects of the blended learning method applied during the lesson unit of? Classification of Living Things and Biodiversity? on students? biology achievement, their biology attitudes and self-efficacy perceptions, their Internet-use attitudes and self-efficacy perceptions were examined; in addition, the students? views about the method and application were also investigated. The present study, in which the pretest-posttest control-group model was applied as the research model, was carried out in the lesson unit of ?Classification of Living Things and Biodiversity? with 9th grade students attending Nevzat Ayaz Anatolian High School in the second term of the academic year of 2009-2010. The classrooms constituting the study group was determined on random basis. In addition, the experimental group and the control group were also randomly determined. As a result, the classes of 9-A and 9-C formed the experimental group, and the classes of 9-D and 9- E constituted the control group. 13 students from the experimental group were not included in data analysis as they either did not take part in the data

collection process or did not follow the activities via the Internet. Thus, the study group was made up of a total of 107 students, 47 whom were in the experimental group and 60 of whom were in the control group. The data collection tools included the biology achievement test developed by the researcher, the biology attitude scale, the biology self-efficacy perception scale, the Internet-use attitude scale, the Internet self-efficacy scale, the scale of learners' views about blended learning and interview questions. The application lasted 11 weeks. Before the applications started, the biology achievement test, the biology attitude scale and the biology self-efficacy perception scale were applied to both groups, while the Internet-use attitude scale and the Internet self-efficacy scale were applied only to the experimental group as pretest. Prior to the application, a meeting was held with the experimental group students in two course hours to inform them about the process. First, they were informed about the blended learning method and about the expectations from them. Following this, with the help of a computer and a projector in the classroom, the website was introduced to the students. They were taught how to sign up the website and were informed about the things they would pay attention to during the activities. In the experimental group, the lessons were taught in a way appropriate to the blended learning method both via the Internet and on face-to-face basis. As the online dimension of the blended learning method, Moodle, a Learning Management System (LMS), was used. The content of the lesson unit of 'Classification of Living Things and Biodiversity' was presented as 8 subjects and made open to students' access via Moodle on the website of www.e-biyoloji.net considering the curriculum. For each subject, the website included summaries, videos, visual presentations (PowerPoint), animations, related links, a dictionary, quizzes, research subjects (homework) and a forum section. In face-to-face environment, the research subjects were presented to the students in the form of discussion and question-answer. In the classroom, by evaluating the activities carried out via the Internet with the help of a computer connected to the Internet, the teacher clarified the points that the students did not understand. In the control group, the lessons were taught on the basis of traditional face-to-face instruction in the classroom environment. Following the application, the data collection tools applied to both groups previously as pretest were applied to the same groups as posttest. In addition, the scale of learners' views about blended learning was applied to the experimental group, and interviews were held with the group. For the analysis of the data, the Kolmogorov Smirnov test, independent samples t-test, paired samples t-test and Wilcoxon signed-rank test were conducted. For these analyses, the SPSS 15.0 package software was used, and the significance level was taken as 0.05. As a result of the analyses of the research data, a significant difference between the Biology Achievement posttest mean scores of the students in the experimental and control groups was found in favor of the experimental group ($p < 0.05$). On the other hand, no significant difference was found between the students' post application scores regarding the biology attitude and self-efficacy perception scales as well as the sub-dimensions of these scales ($p > 0.05$). For the experimental group, the results of the analysis of the data regarding the Internet attitude and self-efficacy perception scales before and after the application revealed a significant difference between the students' Internet attitude pre- and post-application scores in favor of post-application ($p < 0.05$). With respect to the sub-dimensions of the Internet attitude scale, a significant difference was found between the attitudes towards Internet use in teaching, researching and information sharing in favor of post-application. In addition, no significant difference was found between the Internet self-efficacy scale pre- and post-application scores of the experimental group students ($p > 0.05$). As a result of the analysis of the view scale applied to the students to ask for their views about the method and application, it was seen that their views were 'highly' positive. The interviews held with the students revealed that the blended learning method provided students with various opportunities such as getting prepared for the lessons, reviewing the lessons as many times as wanted, reaching the subject-related materials without being dependent on time and place, testing oneself and communicating with the teacher and other students out of the school. The interviews also revealed that there were various problems though such as lack of Internet connection at home and problems experienced while playing the videos. Consequently, if no problems with the infrastructure of the Internet are experienced, it is believed that the blended learning method will be beneficial in biology teaching.

- 79 Zumbach et al., (2014) Biology <https://tinyurl.com/bderx92w> Based on central themes of the Austrian biology curriculum, we developed several online-modules addressing several concepts around the ecology of alluvial forests. These modules were either designed after principles of direct instruction or as problem-oriented learning environment. In a quasi-experimental pre-post-design (N = 463) predictors of learning performance were analyzed comparing direct instruction with problem-oriented learning. Overall, results suggest that learners benefit more from direct instruction than from primarily self-directed problem-oriented learning. A more detailed analysis of predictors for learning performance within a linear regression analysis revealed that this effect is mediated by some other variables. It seems that the basic attitude of learners towards the learning environment influences either deep or narrow information processing. Learners with a high subject-related ability self-concept report about lower mental effort in information processing. This lower mental effort accompanies lower performance compared to learners with low-ability self-concept who invest a higher amount of mental effort and have a higher increase in knowledge acquisition from pre- to post-test. More specific analyses reveal an Aptitude-Treatment-Interaction-Effect showing that this relation is rather distinctive in the problem-oriented condition than in the direct instruction condition.
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