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Advances in Intelligent Systems and Computing 1134

Michael E. Auer
Hanno Hortsch
Panarit Sethakul *Editors*

The Impact of the 4th Industrial Revolution on Engineering Education

Proceedings of the 22nd International Conference on Interactive Collaborative Learning (ICL2019) – Volume 1

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Preface

ICL2019 was the 22nd edition of the International Conference on Interactive Collaborative Learning and the 48th edition of the IGIP International Conference on Engineering Pedagogy.

This interdisciplinary conference aims to focus on the exchange of relevant trends and research results as well as the presentation of practical experiences in interactive collaborative learning and engineering pedagogy.

ICL2019 has been organized by King Mongkut's University of Technology North Bangkok from September 25 to 27, 2019, in Thailand.

This year's theme of the conference was "The Impact of the 4th Industrial Revolution on Engineering Education."

Again outstanding scientists from around the world accepted the invitation for keynote speeches:

- Xavier Fouger, Senior Director, Learning Centers and Programs, Dassault Systemes – Learning Experience. Speech title: *Learning Centers,* a Tidal Wave in Shaping the Workforce of the Future
- Doru Ursutiu, Manager of Center for Valorization and Transfer of Competence, "Transylavania" University of Brasov, Romania. Speech title: Affective Education and New Technologies starting from Music Therapy to Engineering Education!
- Stefan Vorbach, Professor at Graz University of Technology, Graz, Austria. Speech title: The Importance of Entrepreneurship Education for University Graduates
- Aditad Vasinonta, Deputy-Director General, Office of Industrial Economics, Ministry of Industry, Thailand

In addition, an invited speech has been given by

- David Guralnick, Kaleidoscope Learning, USA. Speech title: Creative Approaches to Online Learning Design

Furthermore, five very interesting workshops have been held:

- Methodologies To Build Conceptual Questions For Assessing Important Misconceptions In Engineering-Related Areas
- Getting Ready for IT Program Accreditation in Europe: the Euro-Inf Standard
- Introduction to Modus Toolbox™ IDE Using PSoC® 6 MCUs
- Authentic Learning Strategies to Develop Engineering Competencies for the Twenty-First Century
- Employing Accreditation Requirements to Build Engineering Leadership Components in the Curriculum

Since its beginning, this conference is devoted to new approaches in learning with a focus on collaborative learning and engineering education. We are currently witnessing a significant transformation in the development of education. There are at least three essential and challenging elements of this transformation process that have to be tackled in education:

- The impact of globalization and digitalization on all areas of human life
- The exponential acceleration of the developments in technology as well as of the global markets and the necessity of flexibility and agility in education
- The new generation of students, who are always online and do not know to live without Internet

Therefore, the following main themes have been discussed in detail:

- Interactive and Collaborative Learning
- New Learning Models and Applications
- Research in Engineering Pedagogy
- E-Learning and Distance Learning
- Problem and Project-Based Learning
- Course and Curriculum Development
- Knowledge Management and Learning
- Real-World Learning Experiences
- Evaluation and Outcome Assessment
- Computer-Aided Language Learning
- Vocational Education Development
- Technical Teacher Training

As submission types have been accepted:

- Full Paper, Short Paper
- Work in Progress, Poster
- Special Sessions
- Round Table Discussions, Workshops, Tutorials

All contributions were subjected to a double-blind review. The review process was very competitive. We had to review nearly 570 submissions. A team of about 275 reviewers did this terrific job. Our special thanks to all of them.

Due to the time and conference schedule restrictions, we could finally accept only the best 166 submissions for presentation.

Our conference had again more than 200 participants from 38 countries from all continents.

ICL2020 will be held in Tallinn, Estonia.

Michael E. Auer
Panarit Sethakul
Hanno Hortsch
ICL General Chairs

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Contents

Applying Collaborative Methodological Solutions Around Students in Higher Education

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Abstract. During the digital transformation and digitalisation period, the transformation of the entire education system can be observed, which focuses on new, collaborative and technology-based learning, which makes the application of its effective learning environment increasingly visible. In this type of modern educational environment, with the expansion of the information and digital society, and with the development of new community learning spaces, we can continuously improve our professional competencies. Meanwhile, the informal learning and peer-to-pear learning, is gaining more and more prominence. On the one hand, our research is based on case studies, shared experiences of the teacher candidates in our institution, and on the basis of qualitative structured interviews with the students concerned. The authors would like to use the conclusions drawn from these in the curriculum development and content renewal of mentor teachers and teacher candidates.

Keywords: Collaboration · Mentoring · Informal learning · Learning from each other · Teacher training · Digitization

1 Introduction

Due to the need of permanent learning brought on by the continuous changes perceivable in the economic and social sphere of the information society the outlines of the pedagogical paradigm change become more and more visible. The respective impact concerns not only the transformation of the roles and tasks of teachers, but the specific structure of training schemes.

The phenomena of digital transformation and overall digitalization generates the full modification of the educational sphere [1] leading to new, collaborative and technology-based learning [2] relying on an effective learning environment [3–7]. The given modern educational environment, the expansion of the information and digital society, and the formation of new community learning spaces call for the continuous development of professional competences. At the same time the need for peer learning, that is, informal learning among students involved in the educational process gains an increasing role [8].

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The Department of Technical Education operating a Teacher Training Centre at the Budapest University of Technology and Economic Sciences aims to integrate such new learning forms into the training of students enrolled in engineering and economics education programs. Such new approaches help us to monitor and test the emerging tendencies in education on a continuous basis and students are given an opportunity to find the optimal teaching and learning forms as well. We emphasize the collaborative and cooperative learning schemes during which "while learning takes place via mutual interaction between students and teachers, the existing connection network facilitating interaction plays a significant role as well." [8] Such a feature plays a crucial role in our training profile. The respective student groups ranging between 50–100 candidates enrolled on an annual basis include two types of learners. In-service vocational education teachers with several years of experience frequently coupled with a professional background in the business and economics sphere and those with no teaching experience at all. Accordingly, we built our research on the hypothesis that differing learning habits require different learning environments as well. It was interesting to observe the changing expectations of learner-centred task distribution and the supporting role of the teacher on the part of today's net generation. Consequently, an educational approach based on information and communication technology is essential as teachers familiar with such applications can integrate these devices and procedures in the learning process while motivating students and helping them to recognize the importance of learning. Therefore, the knowledge of such educational technology is indispensable for prospective teachers of economics and engineering, and the given background can be acquired only if they learn themselves.

In our study we provide a survey of training methods and applications supporting the learning effort of our students. We have assessed their views on the respective utility and operational features along with the given methods promoting intragroup knowledge sharing.

At first we present an overview of the most important digital device systems promoting cooperation and collaboration. The given interactive digital services and quiz engines facilitating shared work were selected due to their high popularity at home and abroad as well. Furthermore, such Web 2.0 applications can easily be learned in a short time as they do not require previous knowledge or special skills. Moreover, based on the adaptation of European Union recommendations including the DigComp framework systems short term training programs aimed at the improvement of teachers' digital skills were launched in Hungary. Said programs were developed according to a domestically elaborated digital competence framework system [12–14].

Collaborative and cooperative learning

"While collaborative learning results in realization of shared objectives, in case of cooperative learning the given goals appear on the individual level. Collaboration is an organized, synchronized activity aimed at the formation and maintenance of a perspective promoting the solution of a mutually shared problem. In case of group learning the group members participate in the problem solving effort on a mutual basis, task division or distribution is spontaneous and the given roles can be changed according to the type of knowledge component contributed to the specific work process. Conversely, cooperative learning takes place at the level of the individual learner, students work on

a given theme by themselves and the respective learning outcomes and consequences are presented on an individual basis as well." [9, 10].

1.1 Group Work

Students work on a topic and they present the acquired information individually on their own, then the given information is processed in a shared manner in front of the group. Consequently, students can gain access to each other's knowledge and the continuously available new information calls for continuous interaction as well [11]. The ideal group size is 3 to 4 members who can be selected in a variety of ways resulting in homogeneous or in-homogenous groups. Interactive group work can be performed by the following Web 2.0 services:

1.2 Plickers (https://www.plickers.com)

The establishment of a voting system via a mobile telephone operated by the teacher. The use of Plickers greatly simplifies immediate evaluation. Teachers need only a mobile device and students use a printed white sheet identifiable by a pictogram. When answering the teacher's questions, they raise the sheet and turn it toward him. Depending on the given answer the pictogram can be turned in 4 directions (A, B, C, or D). One disadvantage is that it can only be used in case of multiple choice tests.

The temporary break in connection and the resulting inability to reach the Internet is a frequent problem in schools. The AR-based Plickers offers a solution via turning the classroom into an interactive location without students using their phones or requiring Internet connection.

In order to test the system, it is enough to register at the website and after establishing one or more classes and potentially entering the names of students the application can be downloaded on to a smart phone. Having printed the answer sheets, the system is ready for testing. It is easy to use as the teacher asks a question with four potential answer options. In response each student raises their answer card turned to display the letter representing the appropriate answer. After starting the application, a camera records the answers and the teacher can see each student's replies. At the same time the results are available at the Plickers website. Thus the respective answers can be projected for the whole class to see, and exporting options are available as well.

1.3 Menti (https://www.mentimeter.com; https://www.menti.com)

The Mentimeter is a presentation software enabling students to answer questions via the help of a code. The method does not require any instalment or adjustment as students can use their own laptops, tablets, or smart phones. The respective results can be shown in real time, but it is possible to hide them until everyone finishes answering. Furthermore, there is no need for documentation or additional administration as the results are automatically saved by the webpage and they can be downloaded later as well.

The software helps the teacher in making the lessons interactive via surveying the opinions of students regarding a given question or issue. Moreover, it can also be used

as a formative evaluation device. Another option is establishing a ranking order among the members of the class if they identify themselves by name before answering. Additionally, the system is suitable for preparing a traditional presentation and can help in the compilation of interactive word clouds too.

1.4 Wiki

The system enables students to construct their own knowledge networks and connect various webpages.

"In case of cooperative learning this system helps students to take notes and share them with other learners. Furthermore, the teacher provides an outline for the concept or conceptual system to be discussed while allowing students to explain or define the given components in order to enable them to freely select the topic they will be in charge of. The given system can function as a work or management surface in case of collaborative learning, group, or class projects. The topic to be processed during the specific tasks incrementally increases while the means and intensity of publication or dissemination of the respective material dynamically vary. Consequently, each learner has the same role. Teachers and students can not only expand the content, but can attach data collections to the given pages along with providing feedback or making notes. The system is also suitable for teachers to prepare their own lecture notes and due to the crosslinking feature instructors can cite or make references to each other's websites." [10].

1.5 Blog

The blog is such a system in which one, or less frequently, several authors or bloggers disseminate their publications according to a chronological order. Readers are provided an opportunity to reflect on or make comments to the given entries

The use of blogs in cooperative learning: a group of learners establish a knowledge base by the use of their own blogs while the teacher is in the role of the supporter or motivator of the learning process. The use of blogs in collaborative learning: the instructor makes blog writing and offering comments concerning a specific theme a requirement for passing a given course. Teachers can write blogs themselves and require students to follow it or make comments.

1.6 Media Sharing Applications

Such services facilitate the publication of media content (picture, video, sound etc.) uploaded by users to a previously restricted group depending on a given case. While such applications motivate the user to creative work via the production of the given media component, they function as substantial knowledge bases.

The use of media sharing applications in case of cooperative learning: the teacher identifies themes and students collect respective media components to be shared within the group. The use of media sharing applications in case of collaborative learning: arranging an exhibition or gallery of class work utilizing the given media. The participants can comment or analyse each other's work and the discussion can be

moderated or managed by the teacher. Surfaces created in this manner can promote creativity.
Other uses:

- collections established by the teacher or other professionals can support media sources or references to the given lessons;
- shared media can promote visual education efforts;
- instructional materials including demonstration videos placed on such surface can promote distance learning, independent content creation, and processing.

The following is such a concrete application.

1.7 Padlet (https://padlet.com) - https://en.linoit.com/

The Padlet is a virtual wall to which virtual paper slips can be attached. Such slips could include videos, pictures, simple text, or even Learning Apps tasks. The wall can be shared with learners so they can work on the given tasks at home. Furthermore, differentiated learning activities and anonymous use options are available as well. In addition, the wall facilitates gamification, as students can select from assignments to be solved. The application also makes the collection of the ideas of learners and colleagues in a given topic and question possible. Students only need a smart device and they can take notes on-line, and sharing can take place via QR code or link. Unfortunately, this application is not free of charge anymore, only three pages are available without a fee [15].

The most frequent user options provided by the Padlet are:

- Brainstorming
- Question bank
- On-line student portfolios
- Conceptual maps
- Exit ticket

2 Community Bookmarks

These options allow the user to save the addresses of webpages into a list for availability of content he considers important in the future. Each component of the bookmark can be labelled with key terms facilitating a grouping effort. The book mark collection receives a community role when we share them with others. Consequently, the shared bookmarks and the respective labels form a large, mutually usable set enabling the user to identify the websites marked by the given label. Compared to the use of search engines information acquisition can become easier this way. At the same time, we can find users interested in similar topics. Therefore, it is recommended to follow or monitor such collections as it facilitates obtaining up-to-date information. The use of bookmarks in cooperative learning: students and the teacher sharing their own bookmarks can help each other in obtaining information via using the resulting content during a project work. The use of bookmarks in collaborative learning: the

teacher establishes a bookmark set of a given theme by the help of learners, thereby constructing the reference register of a given theme. The labels help in the categorization of the specific sources. The bookmarks related to the given subject can be shared with the learners thereby establishing a reference knowledge base. One such specific application is the Symbaloo.

2.1 Symbaloo (https://www.symbaloo.com)

The Symbaloo is a webpage for the collection of links facilitating individual learning routes. It is suitable for the creation of digital bookmarks regardless of the given search engine. One's favourite links can be found via any computer and the links can be shared as well.

Links to frequently used or essential webpages or web 2.0 applications should be built in a digital tile on the opening pages.

All favourite webpages are automatically synchronised with the smart phone, or the tablet after downloading the Symbaloo application and registering.

It is very easy to operate, and favourite websites or applications can be added by one click. The links can be grouped into a digital tile according to location, colour and/or pages, or themes. Its favourable appearance is coupled with an ability to create an attractive webmix or emphasizing links and topics. Students will enjoy the webmix to be used during project or class work. Students can be provided superfast access to websites via sharing the link in e-mail or on social media surfaces (Fig. 1).

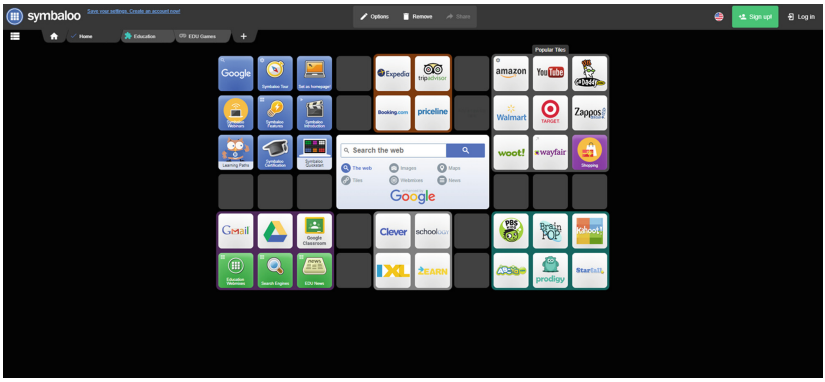

Fig. 1. Symbaloo. Source: author's own compilation

3 Applications Constructing Conceptual or Cognitive Maps

Conceptual maps describe the given concepts and the respective connection system. Cognitive maps depict a thought system built around a central idea. By the help of web-based conceptual map and cognitive map preparation programs community figures can be elaborated and participants can construct the given maps together.

The use of such devices in cooperative learning: students prepare conceptual maps on their own and later share it with the group.

- The use of such devices in collaborative learning: the teacher identifies a topic and the groups prepare the respective conceptual map.
- The teacher shares the previously prepared map with the students or assigns additional task based upon the given figure.

3.1 RSS Channels

RSS channels help users to read the content of the given websites without actually visiting the specific pages. Various channels can be collected on a uniform surface to be grouped according to different criteria later. Consequently, users are notified of any change in a given website without the need to visit it. Such contents can be shared with others on a common surface and if needed comments can be added. While they cannot be used for collaborative or cooperative work directly on their own, they can support group efforts in an indirect manner.

A few examples of their use:

During group work including wiki-based uploading of content members of the group can be immediately notified of the changes related to the project work, teachers can publish crucial information concerning the arrangement or content of the given courses. Relevant articles obtained from different channels can be shared by learners and students as well. Furthermore, both teachers and learners can recommend channels to the group for the purpose of sharing knowledge.

Naturally the abovementioned equipment or devices are only samples from a wide variety available. These tools can be used either on their own or in a mixed manner. Below maintaining a somewhat distant perspective (not on device level) I will introduce a few methods motivating learning and utilizing either cooperative or collaborative approaches.

3.2 Project Work

During project work students can prepare unique products, services, or outcomes via a realistic, lifelike activity. A good project evokes student interest and proves to be significant and rewarding. Projects usually are inspired by questions and lead to further questions or issues promoting research. The teacher initiates the project, provides assistance in launching the effort, finding resources and in interpreting the respective results. It is crucial that students feel an ownership of the project. During implementation students can use web 2.0 devices and the outcomes can include wiki-type results, blogs, or diverse forms of media repositories. Project goals can be realized either on cooperative and collaborative foundations whose distinctions we have discussed earlier.

3.3 Students Teaching Each Other

Community-based learning is one of the most advantageous forms of teaching and knowledge acquisition. This approach helps to improve student confidence, reinforces a positive attitude toward the given subject and the work effort in general. Teachers have to inspire students to share their knowledge with each other via the various sharing applications. At the same time in addition to sharing teachers have to allow students to become each other's tutor as they should not rely solely on the teacher for assistance but help each other via the solution of tasks and problems. While only knowledge is shared among the students the type of learning is considered cooperative, collaborative learning requires mutual mentoring or tutoring.

3.4 Cooperating Groups

The first tasks are usually assigned by the teacher and the groups will gradually reach the independent problem identification and solution stage. Teachers play a crucial role in this process as after the identification or presentation of a specific problem they enable students to find questions and the respective solutions in a more complex manner. This method promotes interaction and cooperation among students with various backgrounds, the integration of their peers coping with learning disabilities, and the development of a cooperative problem solving strategy. In this case the teacher fulfils the role of advisor or counsellor within the group. The given training systems facilitate the formation of the groups and the use of web 2.0 devices including wiki in the implementation of the cooperative work process. As the specific tasks become more complex the group work can become more collaborative as well.

4 Our Empirical Research

Today's information-based society requires experience-based knowledge acquisition via a learning environment motivating a critical attitude and the achievement of significant results. Students searching for answers on their own experience the difficulties and joy related to a research process in addition to exploring and mapping the correlations and rules and constructing a personalized knowledge network of a given theme. Knowledge acquired via independent research tends to be more durable and long-lasting than that of obtained during frontal teaching imparting external knowledge patterns. Web 2.0 devices can provide a significant background for the research effort enabling students to exchange their research results and constructing their own knowledge network via continuous feedback. Research can be performed individually via cooperatively monitoring feedback or in a collaborative form while exploring a given theme in a group format.

4.1 A Sampling of Our Research Results

One of the goals of our teacher training program is to familiarize prospective teachers with digital devices via assignments promoting the integration of ICT systems into their

pedagogical practice. The given schemes call for feedback on digital communication options. Consequently, in the autumn of 2018 we surveyed the members of the abovementioned target group on their views concerning the integration of the respective technological options. While we prepared a statistical analysis of the 80 answers, below by the help of descriptive statistical methods we provide a brief diagram and textual description of the most informative research results (Fig. 2).

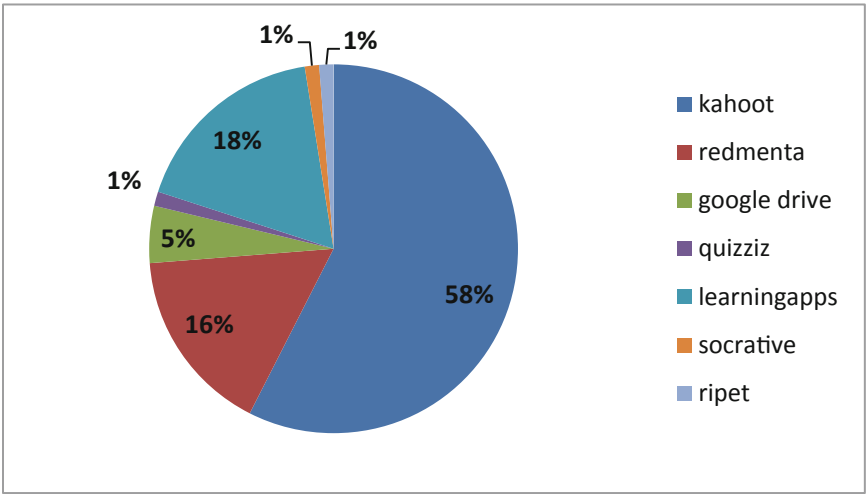

Fig. 2. The distribution of the types of interactive student tasks related to pedagogical practice. Source: author's own compilation

The above diagram clearly shows that the "kahoot" digital quiz preparation program was the most popular. This service developed in Sweden was followed by the "learningapps" with 18% using rate and 16% of students relied on services provided by the "redmenta." Furthermore, 5% of the respondents prepared its tasks with the help of the Google drive.

4.2 Evaluation and Summary

Learners can take responsibility for the knowledge acquisition process if they can determine the given objectives and the criteria for implementation and evaluation. Consequently, the specific learning process must include an evaluation or assessment component. In case of cooperative evaluation the group assesses the work after completion, while during collaborative learning evaluation takes place during the given effort as the formation of a shared knowledge network necessitates continuous re-evaluation.

In sum our research effort examined the efficiency of the aforementioned digital services in pedagogical practice along with the benefits they provide for prospective teachers We also examined how such advances can be integrated into the respective

methodological culture. At the same time we asked our students enrolled in teacher training programs for a brief reflection or feedback regarding their views on the effectiveness of said methodological renewal.

Our short and long distance goal is the expansion of ICT-based methodological innovation provided by digital pedagogy. Such approach not only improves digital skills, but can lead to increased student satisfaction and academic performance via the application of best practices and methods.

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