

Mapping, scientific review on peer-to-peer learning in mechatronics

Dan Rusu, Alexandru Ianosi, Dan Stan, Christine Galez, Laurent Tabourot, Albert Meij

► To cite this version:

Dan Rusu, Alexandru Ianosi, Dan Stan, Christine Galez, Laurent Tabourot, et al.. Mapping, scientific review on peer-to-peer learning in mechatronics. [0] Intellectual Output 1, Technical University of Cluj-Napoca; Université Savoie Mont blanc; Hochschule Kaiserslautern - University of Applied Sciences. 2020. hal-03764548

HAL Id: hal-03764548 https://hal.science/hal-03764548

Submitted on 30 Aug 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers. L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License





Erasmus+ Strategic Partnerships for higher education

XP2P

CROSSING BORDERS: PEER-TO-PEER EDUCATION IN MECHATRONICS

IO1 REPORT

Project Title	Crossing Borders: Peer-to-Peer Education in Mechatronics 2019-1-FR01-KA203-062208
Output	O1 - Mapping, scientific review on peer-to-peer in mechatronics
Date of Delivery	14 th March 2020
Authors	Dan Rusu, Alexandru Ianoși, Dan Stan (UTCN) Christine Galez, Laurent Tabourot (USMB) Albert Meij (HSKL)

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.











Contents

1.	Introduction	. 3
2.	Definition of peer-to-peer learning	. 5
3.	Method used to prepare this review	. 6
	The limits of our bibliographical research Quantitative and qualitative analysis	. 6 . 6
4.	State of the Art	12
5.	Peer-learning approach	17
	Advantages of "peer to peer learning" Teaching in mechatronics	17 19
6.	Conclusions	23
7.	Bibliography	24

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.











1. Introduction

One of the fundamental characteristics of what makes us human beings is the ability to organize the learning process. This gives us the ability to successfully pass vital information across many generations, every one of which further improves upon it and broadens the knowledge. Many learning methods, more or less formalized, were employed along the history of the humanity, with various results. In a very primitive form, peer-to-peer learning is something that every society, regardless of size, always did. It poses enormous advantages, many of which will be discussed in this report, but one is very attractive: it strengthens the social bonds within a group of people, nurturing trust and respect between the members. It is postulated that our current age simultaneously interconnects peoples around the globe, but the digital interaction lacks the depth of real-life communication. As even the learning process migrates towards digital platforms, the importance of peer-to-peer learning readily becomes apparent. Therefore, it is important for the education system to adapt its teaching, learning, and assessment methods.

The education system is a subsystem subordinated to the social system and it has the obligation to adapt to the changes coming from the society. It is therefore important that the teaching, learning and assessment methods of the education process keep pace with society evolutions. The models of current educational system have been strengthened on the basis of contemporary or new pedagogical ideas and principles, which more and more emphasize the importance of building competences and skills. This change in the modern educational system is characterized by: the "reconfiguration" of the pupil/student who becomes the subject of education through learner-centered approach instead of teacher-centered approach, the use of modern teaching methods (computer, video projector, virtual reality (VR) or augmented reality (AR), flipped classroom, project-based learning, e-learning, use of ePortfolio...), the development of critical thinking and problem-solving ability, and a very important aspect represented by the experimental - interactive learning that leads to learning and understanding in depth. In the contemporary world, learning should be viewed as a process of evolution/change, and not viewed only as a resultant product [Ion01]. We believe that peer learning, i.e. learning with and from each other, is an important form of learning.

The aim of the XP2P-project is to implement peer-to-peer learning during a semester/module for post-graduate students in mechatronics, connected to the

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.







XP29





implementation of a suitable competency portfolio assessment for guidance and documentation of the progress. Project-based learning, in combination with peer-to-peer learning, will enable students to acquire improved cross-functional skills, such as: technical skills, social skills, resource management skills.

Mechatronics, from an educational point of view, is formed by associating and interconnecting the disciplines of mechanics, electronics, control science and computer science, reaching a multi-disciplinary stage in which these fields merge. Based on this merge, it was necessary to organize new programs and new courses adapted to the new field. The mechatronics domain has a very applicative foundation, which is why this field adapts very well to the demands of companies or industries that focus on the accumulation of competencies and skills. This applicative approach of mechatronics requires, of course, also adapting traditionalist educational methods, with some methods based on group activities developing competencies, skills, critical thinking and therefore a greater assimilation of knowledge and an easier integration in a multicultural collaborative work placement. We aim to create innovative learning and teaching practices in mechatronics at the master level. Our expectation from the XP2P project on our organizations is to gradually break away from traditional teaching patterns and to show the possibilities beyond.

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.











2. Definition of peer-to-peer learning

At this point, a definition might have been: "more able students helping less able students to learn in co-operative working pairs or small groups carefully organised by a professional teacher" as defined by K. J. Topping in 1996 [Top96].

But lately, the same author defined peer learning as "the acquisition of knowledge and skill through active helping and supporting among status equals or matched companions. It involves people from similar social groupings who are not professional teachers helping each other to learn and learning themselves by so doing" [Top05]. In the same reference, two types of peer learning are identified:

- "Peer tutoring (PT) is characterised by specific role-taking as tutor or tutee, with high focus on curriculum content and usually also on clear procedures for interaction, in which participants receive generic and/or specific training. It is characterised by positive role modelling, promotion of raised aspirations, positive reinforcement, openended counselling, and joint problem-solving. It is often cross-age, always fixed-role, quite often cross-institution, and often targeted to disadvantaged groups."
- "Cooperative learning (CL) is more than "working together" it has been described as "structuring positive interdependence" .../... in pursuit of a specific shared goal or output. This is likely to involve the specification of goals, tasks, resources, roles, and rewards by the teacher, who facilitates or more firmly guides the interactive process."

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.







Hochschule Kaiserslautern University of Applied Sciences ഹ





3. Method used to prepare this review

The limits of our bibliographical research

The methodical review is mainly directed by scientific articles in the results retrieved from the found literature. The results were partially affected by the sources of the retrieval which can be used (the Web of Science, Science Direct, IEEExplore and Google Scholar) and the complex request used. By including extra methods such as citation context analysis we could obtain more in-depth analyses on peer-to-peer learning.

Quantitative and qualitative analysis

In order to follow the evolution of the modern research about peer-to-peer learning over the years, we elaborated a graph representing the number of scientific articles over the period 1996-2019 issued by reviews related to educational field. We used as keywords in the search for data "peer-to-peer" learning (Science Direct).



Figure 1 Number of publications related to peer-to-peer learning published each year, according to a database query made on Science Direct platform.

The presented diagram spans the period from 1996 until 2019 and we can very clearly deduce from it the evolution and interest on this field over the years and up to now. From this diagram we identify two very important stages. These are the launch stage and the development stage. Analyzing it, we can deduce that the launch period of peer-to-peer learning method extended between 1996 and around 2000. During this period, the principles of this method were partially fixed, and this period was, at the same time, characterized,

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.













considering the publications, by a small number of publications: about 28 in 1996-1997 and about 85 3-4 years later.

Analyzing the development stage that started after 2000, we can deduce that in this period, the number of publications regarding this field has increased from year to year, reaching in 2019 a total number of 1164 of publications on "peer-to-peer" learning. According to the graph (Fig. 1), we realize that this area is still in the development stage.

304 EDUCATION EDUCATIONAL RESEARCH	237 Computer Science Theory Methods	158 TELECOMMUNICATIONS	154 Computer Science Artificial Intelligence	126 COMPUTER SCIENCE INTERDISCIPLINARY APPLICATIONS	
256 COMPUTER SCIENCE INFORMATION SYSTEMS	227 ENGINEERING ELECTRICAL ELECTRONIC				
		95 COMPUTER SCIENCE HARDWARE ARCHITECTURE	90 EDUCATION SCIENTIFIC DISCIPLINES	69 Computer Science Software Engineering	

Figure 2 Number of publications related to peer-to-peer learning by domains, according to a database query made on Web of Science [WWW01]; it shows the main areas of education where research about this method was carried out.

The peer-to-peer learning method has been adopted and implemented in different areas, where there is a need for efficient transmission and learning of information, skills, and abilities. Following the diagram of figure 2, which represents the top 10 distribution of the number of scientific publications in different educational domains published in the *Web of Science*, we observe that the largest number of publications corresponds to the field of educational research.

This fact is not surprising, as this domain presupposes constant developments to reach an updated and competent educational process to improve the effectiveness of the educational action in all fields.

However, an interesting point in this classification is the fact that the other 9 domains are part of exact sciences, and that computer science is highly represented. The motivation for interest in the peer-to-peer learning method in these disciplines may not be as clear at first

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.













sight as it is for educational research, but it might find its roots in the way these domains are changing: for instance, nowadays, one can gain a sufficient foundation in some areas by attending online courses such as Moocs (Massive open online courses) providing peer assessment opportunities. Another example is the development of a very active community dedicated to electronics projects, where the entrance barriers were significantly lowered by the widespread use of open hardware platforms like Arduino. Another interesting trend is the fact that machine learning technologies have begun to be more accessible to a wider audience: tools that were once affordable only to researchers are now accessible through open source or freemium models, complemented by a large collection of video demonstrations of how to use them; this context enables and empowers peer-to-peer learning by providing out-of-class resources.

These trends open a very large opportunity for students in mechatronics since more often than not, they come to a laboratory activity already primed by seeing a video demonstration or they have actually built something for themselves by following online instruction and they already have a quite good idea of what the laboratory activity will be about. Therefore, by encouraging students' interactions, there are specific areas where it is advantageous to implement a peer-to-peer learning approach in order to capitalize on this potential given by the current means of mass communication.

Figure 3 illustrates how the research in this area is put to use: most of the already little exploration is concentrated in research papers, either in journals or in conference proceedings, and very little is put to use into books; at most, the subject is addressed as a chapter in a book, very few authors took time to dedicate ample space to peer-to-peer learning. This is a little surprising, as learning from peers has been existing informally since the dawn of time; it's quite interesting how modern educational methods are actually a formalization of what is a natural ability for most people: information sharing.

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.







Hochschule Kaiserslautern University of Applied Sciences ∞

XP29





Figure 3 Number of publications related to peer-to-peer learning by source type, according to a database query made on Web of Science [WWW01]; it shows in which type of documents most of research related to peer-to-peer learning has been reported.

A very good source for probing the interest of the society at large is the number of queries in the most popular search engine: Google. The company behind this service also offers free of charge search-queries analysis through the service Google Trends. An investigation into the past 5 years by using the search criteria: "peer-to-peer learning" reveals a small but steady increase in using this phrase into the search engine, quite exclusively from the United States (see figure 4).

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.















Figure 4 Peer-to-peer learning search results

This contradicts the reality found in the scientific literature, as the authors of various articles are not only from the US. A further search on Google Trends done using the criteria "peer learning" reveals that there may be nomenclature differences between US and the rest of the word, as this phrase was more often used into the search engine by people out of the United States. Also, the trend is much more accentuated, "peer-learning" being used much more in the search engine, compared to the query "peer to peer learning".

Another trend can be observed in Figure 5 relative to the keyword "Peer assessment" where the map shows a different spread of interest.

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.







Hochschule Kaiserslautern University of Applied Sciences 10

Page



Figure 5 Google Trends analysis for search criteria "Peer assessment"

These results show that peer education is a matter of interest in several countries.

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.







Hochschule Kaiserslautern University of Applied Sciences Page | 11





4. State of the Art

In order to properly study the state of the art in the area of peer-to-peer learning, a search query on the platform Web of Science with the exact phrase "peer to peer learning" was set. It is important to note the usage of quotation marks in the search field, otherwise the search engine will return results related to the computer science concept of peer to peer data sharing. This approach found a number of 166 papers, which were ordered by number of citations; top 10 papers were selected and centralized in the table 1 below.

NՉ	Title	Author(s)	Year	Cit.	DOI
1	The Active Living by Design National Program Community Initiatives and Lessons Learned	Bors, P. et al.	2009	73	10.1016/ j.amepre.2009.09.027
2	Beyond hype and underestimation: identifying research challenges for the future of MOOCs	Fischer, G.	2014	59	10.1080/ 01587919.2014.920752
3	A new vision for distance learning and continuing medical education	Harden, R.M.	2005	57	10.1002/chp.8
4	A hybrid recommendation algorithm adapted in e-learning environments	Chen, W. et al.	2014	50	10.1007/s11280-012-0187-z
5	Best management practices and timber harvesting: the role of social networks in shaping landowner decisions	Knoot, T.G. et al.	2011	37	10.1080/ 02827581.2010.545827
6	Serving members and reaching others: The performance and social networks of a landowner cooperative	Rickenbach, M.	2009	33	10.1016/j.forpol.2009.08.006
7	Generating 'good enough' evidence for co-production	Durose, C., et al.	2017	17	10.1332/ 174426415X14440619792955
8	The Coral Triangle Initiative and regional exchanges: Strengthening capacity through a regional learning network	Pietri, D.M. et al.	2015	15	10.1016/ j.gloenvcha.2015.05.005
9	Mediating Knowledge through Peer-to- Peer Interaction in a Multicultural Online Learning Environment: A Case Study of International Students in the US	Sadykova, G.	2014	15	10.19173/irrodl.v15i3.1629
10	Creating a Supportive Environment: Peer Support Groups for Psychotic Disorders	Castelein, S., et al.	2015	14	10.1093/schbul/sbv113

Table 1: Top ten relevant articles regarding peer-to-peer learning

Bors et al. [Bor09] approach the peer-to-peer learning as a tool for promoting a good health by means of physical activity; one of the lessons learned during the 5-year programme, was the fact that peer-to-peer learning was a powerful tool to build capacity of promoting a healthy life-style and that in itself it was important for the success of the programme. Fischer

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.













[Fis14] identifies that one of the problems of massive open online courses is the lack of peerto-peer learning, and the fact that most students regard teacher-provided materials as more valuable than the ones provided by their peers, regardless of the objective quality of that materials. Harden [Har05] recognizes the importance of peer-to-peer learning in undergraduate programs and considers it of utmost importance in postgraduate and continuing education as it creates a community of learners, a highly developed learning environment by experience sharing among experts. Chen et al. [Che14] recognize the thread that massive, uncategorized and heterogeneous learning resources pose to the process of learning (it is hard to find what one really needs), and propose an algorithm capable of collaborative filtering and sequential pattern mining that is applicable in peer-to-peer learning communities.

An obvious approach is the usage of peer-to-peer learning in a business environment; Knott et al. [Kno11] and Rickenbach [Ric09] analyze how suitable is such an approach in the timber industry, by measuring the effect of forestry professionals' social network on the improvement of management practices in the timber harvest process. They conclude that the viability of peer-to-peer learning relies on its long-term change it brings about in the relationship between institutional, community and market actors. Another idea is presented by Durose et al. [Dur17], who propose that in the context of co-production (a concept that aims to involve different groups traditionally seen as separate, e.g. producer and user) peerto-peer learning might be used as a good way of data gathering, as groups of people who share a passion deepen their expertise through interaction.

Peer-to-peer learning benefits also environmental sciences, as described by Pietri et al. [Pie15], because even in instances of socio-cultural differences, a shared cause has the potential of bringing participants together, but equally important in this case is the existence of a coordinating body, as the social networks rarely have the capacity of implementing or sustaining activities in this field. The problem of interaction in a multicultural learning environment was approached by Sadykova [Sad14], who found that while courses designed primarily for local classes pose significant difficulties to international students, peer-to-peer learning alleviates said difficulties, despite the fact that some students didn't feel they had a relevant contribution themselves to the group, and as such were not very fond of collaborative activities. **The cited paper concludes that the instructor has a tremendous responsibility of establishing support group, to ease the inclusion of international students in the group.** An

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.







Hochschule Kaiserslautern University of Applied Sciences ⁵age | 13





interesting approach is presented by Castelein et al. [Cas15], who propose a broadening scope for the support groups dedicated to people with a psychotic disorder in order to include peerto-peer learning, in which the patients might freely share their experience with each other so everyone might learn from it.

Unsurprisingly if we take into account the results found in the previous chapter of this report, the second search query, "peer learning", has yield a much greater number of hits on the Web of Science platform, that is 1254 papers dealing with this topic. Also, in this category, the articles generated a much larger number of citations. As previously done, the top 10 relevant papers were centralized in the table 2 and are discussed further below.

N⁰	Title	Author(s)	Year	Cit.	DOI
1	Reliability and Predictive-Validity of the Motivated Strategies for Learning Questionnaire (MSLQ)	Pintrich, P.R. et al.	1993	1156	10.1177/ 0013164493053003024
2	The state of cooperative learning in postsecondary and professional settings	Johnson, D.W. et al.	2009	270	10.1007/s10648-006-9038- 8
3	'Peer learning' as pedagogic discourse for research education	Boud, D. et al.	2005	162	10.1080/ 03075070500249138
4	Student teaching: views of student near- peer teachers and learners	Bulte, C. et al.	2007	148	10.1080/ 01421590701583824
5	Mutual peer tutoring: Effects of structuring tutorial interaction to scaffold peer learning	King A., et al.	1998	132	10.1037/0022- 0663.90.1.134
6	Self-regulated learning strategies & academic achievement in online higher education learning environments: A systematic review	Broadbent, J. et al.	2015	127	10.1016/ j.iheduc.2015.04.007
7	Teaching Students and Teaching Each Other: The Importance of Peer Learning for Teachers	Jackson, K. et al.	2009	123	10.1257/app.1.4.85
8	Discourse patterns for mediating peer learning	King A.	1999	114	10.4324/9781410603715
9	Effects of problem-based learning and traditional instruction on self-regulated learning	Sungur, S. et al.	2006	98	10.3200/JOER.99.5.307-320
10	An analysis of peer interaction patterns as discoursed by on-line small group problem-solving activity	Liu, C.C. et al.	2008	88	10.1016/j.compedu.2006.0 7.002

Table 2: Top ten relevant articles regarding peer learning

One of the oldest and most cited studies that assessed the reliability of peer learning among other education strategies was done by Pintrich et al. [Pin93], and, in the framework of their method, they found that peer learning was generally weakly correlated with the

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.













studied cognitive strategies (rehearsal, elaboration, organization and critical thinking). Johnson et al. [Joh07] remark that despite the fact that cooperative learning as a concept began in the 1960s, its use was resisted by those who advocated social darwinism and individualism. Within a group, the dynamics can lead either to positive interdependence (individuals perceive that they can reach their goal if the other individuals within the group are also successful) or negative interdependence (individuals perceive that they fail). Positive interdependency is not to be confused with the lack of conflict: the cited study highlights indeed the benefits of constructive controversy, which arises when the members within a group have different information. In such a context, peer-learning can thrive.

Boud et al. [Bou05] argue that peer learning, if properly formalized, provides a productive framework for research education; it involves learning from fellow students, usually away from the teacher, but also from co-workers/collaborators. The process is not without dangers, as pedagogy is not a simple laissez-faire provision of resources and one cannot easily assume the reciprocity and equivalence between peers. Another proposal, made by Bulte et al. [Bul07], is the implication of senior students in the process of teaching their junior peers; their study aimed to find exactly what teaching role a senior student might fulfill, and found that although the planner and resource developer roles were more suitable for formal instructor, the role of information provider, role model and facilitator were actually quite suitable for them. The study concludes that peer learning is an important curricular consideration.

King et al. [Kin98] studied how different methods of peer learning (explanation, inquiry and explanation, and sequenced inquiry plus explanation) affect the effectiveness of the process in the case of seven graders.

They found that sequenced inquiry plus explanation allowed for the best performance on written performance measurements.

Broadbent et al. [Bro15] examined different studies related to peer-learning in the context of online courses and found that peer-learning has only a moderate effect on improving the overall outcomes, which might suggest that in an online context, it might be less effective or there are other unexplored factors specific to this setting that prevent its effectiveness. The importance of peer learning for teachers was addressed by Jackson et al. [Jac09], who concluded that especially for young, unexperienced teachers, exposure to a group of more experienced ones has a measurable effect on the quality of the students' performance, and

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.







Hochschule Kaiserslautern University of Applied Sciences







that compensation schemes that reward a teacher relative to his/her peers hampers the overall quality of the group due to the fact that it is detrimental to fostering peer learning.

In [Kin99], A. King proposed three main types of peer learning discourse pattern used successfully "to assist peer learning groups in mediating their own learning". They are based on student-generated questions and answers by the peers. Each type of discourse pattern, based on generating and answering questions within the peer group, is adapted to a particular type of peer learning. First, the discourse pattern for peer mediation of complex knowledge construction is described. This includes the comprehension discourse pattern which allows the monitoring of the "comprehension of terms, processes and the like" in learning activities as well as the (extended) knowledge construction discourse pattern which allows the construction of new knowledge. They were observed during sessions where peers generated open-ended thought-provoking questions and answered them, after being trained in generating comprehension questions or integration questions. Then, the author described the discourse pattern for peer mediation of problem solving. Here peers generate structured strategic questions about planning, monitoring or evaluation questions and thoughtprovoking questions. Finally, in the discourse pattern for peer tutoring, a peer plays the tutor role, is the "questioner" and only asked questions whilst the other peer plays the tutee role and is the "explainer". Five types of questions can be generated by the "questioner": review, thinking, probing, hint and metacognitive questions. According to the author, "tutoring partners jointly scaffold their learning to progressively higher levels" through this type of discourse.

Suntgur et al. [Sun06] found that peer-learning is greatly improved using problem-based learning with ill-structured tasks, much better than in a traditional, teacher-centered, textbook-oriented setting. Liu et al. [Liu08] analyzed five peer interaction patterns (centralized knowledge exchange, distributive knowledge exchange, group development impediment, ability impediment and partial knowledge exchange), and found that **teacher interaction is still needed to moderate the distribution of knowledge**.

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.











5. Peer-learning approach

Advantages of "peer to peer learning"

Regarding education, several methods can be adapted to reach the desired objective: a higher learning degree. There are several methods for knowledge and skills transmission which are either part of the traditional methods or part of the modern teaching-learning-evaluation methods. Every teacher is free to choose the appropriate strategy in order to reach the goal. Learning from a peer to peer learning approach is part of a modern and active educational strategy which integrates several methods, such as oral or written exposure, teamwork methods, practical work and problem solving. Peer learning can add individual advantages for a greater integration of individuals in the social system. Today, the peer to peer learning is more frequently used because of the advantages it presents in more and more contexts and variants in various disciplines in more countries [Bou01].

Figure 4 shows that "peer learning" Google queries emanate primarily from Australia, the United Kingdom, the United States, Canada, Italy and Sweden during the last five years. These countries with a strong economic, social, political development are investing heavily in human resources, finding new ways to keep up with the development of society.

This appears also on the map representing the tertiary attainment of the 25-64-year-old population (figure 6) especially for Australia, the United Kingdom, the United States, Canada and Sweden.



The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.







Hochschule Kaiserslautern University of Applied Sciences age | 17





Figure 6: Tertiary attainment of the population calculated as the share of 25-64 year olds that have attained a tertiary level of education (2018). [source: https://www1.compareyourcountry.org/education-at-a-glance, website of the OECD)

Applying the method of peer-to-peer learning, the individual could obtain a series of skills, competencies that would not have been so easily gained by other teaching-learning methods. For example, the advantage of this method would be to prepare individuals to learn effectively. This term of "efficiency" refers to a skill that the individual gains in the learning process through a turn on the way of thinking about learning. The consequences of this ability produce a change of the individual at a behavioral and social level through a positive, active and operative social approach. Another example would be that this method is carried out by a group of individuals who share the same problem they want to solve, leading to the creation of a learning community.

These learning communities are active and evolving parts in solving problems through the expectations and involvement of each individual.

What is important in such a learning community is that individuals communicate with each other about their needs and expectations and develop trust between them, driven by a common perspective. Nowadays, most industries and services demand working in teams for fulfilling various tasks, while peer-to-peer method could be effective in this way as well, as it forms and prepares the individual for working together with other individuals.

That is why in formal, institutionalized education of individuals, a greater integration of informal education is wished. What is essential in a community or in a team, is that the individuals have the right and freedom to freely express their opinions, beliefs and thoughts. This freedom of expression is essential for the development of the individual in society and is also considered as a constitutional right, in most countries. By expressing ideas, the individuals also develop concepts in some of their areas of interest, as well as some self-management skills [Bou01].

Over time there have been a lot of research related to modern methodology based on peer-to-peer learning activities, in which it has been experimentally observed, that this method can help reduce stress, depression and anxiety, by allowing individuals to communicate and express their ideas within the group [Ben17]. This finding is a very important one especially in the 21st century, when there is a major problem with illnesses and disabilities

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.











caused worldwide by depression and stress. According to the World Health Organization, in 2017, over 300 million people, representing 4.4% of the world's population at the time, were suffering from depression, up 18% more in comparison to 2005-2015. The Organization also says that by 2020, depression will become the second largest cause of disease, and by 2030, it will become the leading cause of disease worldwide [WHO17]. Therefore, a solution to reduce stress and implicitly the diseases caused by it, would also come from the educational environment: by approaching the modern teaching-learning-evaluation methods, which would facilitate the interactions between individuals through communication.

At the same time, it is found that peer-to-peer learning offers more often the possibility for individuals to self-evaluate their knowledge, as well as to realize in which areas they still need improvement. Another feature of this method is the fact that it offers individuals greater flexibility of interaction which makes it much more relaxing and comfortable [Ben17].

Another important aspect of this method is the learning mode which refers to learning in depth, as well as to the improvement of critical thinking and problem solving [Gra19]. Figure 7 summarizes some of the advantages of peer to peer learning.



Figure 7 Advantages of "Peer to peer learning"

Teaching in mechatronics

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.













The diversification of teaching methods and the increase of the quality of learning methods are used to highlight the students' potential, but also their initiative and creativity and represent the main orientations or inclinations in developing and completing the teaching. This diversification results in improvements such as the development of cognitive components together with their activation, acting as a stimulator of the student's personality.

The curriculum is the one that determines the necessary adaptations of methods, according to different levels: the content taught, the evaluation of the strategies used, but also the result, that is the obtained skills. In the case of mechatronics, there is the concept of changing the classical teaching approach in which the individual achieves a passive theoretical learning, with an active participatory manifestation. This approach is part of the new education structure characterized by a democratic and modernizing vision. Mechatronics education represents a valuable approach in the propagation of interdisciplinary, which promotes creativity, initiative, and cooperation, leading to a promising solution in the cases of professional reconversion [Dac15].

Over time, concepts regarding mechatronics have been introduced in universities and schools specialized in mechanics, as they provide students the chance to gain specific knowledge and skills considered helpful for their further integration in companies. For example [Kur02]: at the Mechanical Engineering School in Atlanta, USA there has been organized a research project in which the course information was combined with elements of mechanics and mechanical design, and in which students had to develop a mechatronic system. Regarding this project, the participants were divided into groups of 3-4 students. In this project-based learning, some objectives were imposed such as: teaching students the basic techniques in mechanical design, developing written and oral communication skills, gaining mechanical processing skills, learning general concepts about mechatronics, as well as teamwork. The final project was found to have reached all the goals and the students have accumulated new skills and concepts very important for their future career. Therefore, this project was a success and at the same time confirmed again the usefulness of mechatronics as an interdisciplinary science.

From this example, most of the knowledge and skills were accumulated through the project that the students had to complete. That is why the project-based learning method (PBL) is more and more used in the engineering field due to its effectiveness [Leh08], [Alp05].

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.







Hochschule Kaiserslautern University of Applied Sciences Page | 20





Project-based learning is an alternative method, as well as peer-to-peer learning, to the traditional methods that the teachers have in the foreground. Another aspect that both PBL and peer-to-peer learning have in common is their focus on group activities.

Therefore, the two methods share a similar approach and combination of both seems very relevant for the XP2P present project. In order to be able to quantitatively determine the effects of this method (PBL) on individuals, it was necessary to compare the effects of projectbased learning method with the effects of traditional methods. There were 46 comparisons taken from 30 scientific articles and published between 1998 and 2017, which represents a sample of 12585 students from 189 schools in 9 countries. The results show that project-based learning had a positive impact, namely between medium and high, on student outcomes [Che19]. It is true that the project-based learning method brings benefits to the training of individuals, but an important part of these results lies in the choice of projects that minimize or maximize the benefits obtained from this method. For the projects to bring the greatest benefits they generally have to be based on a real engineering problem and by being solved, they will also benefit industry. Another obvious feature of the chosen projects would be to include essential elements of mechatronics, such as mechanical, electrical and control elements. Also, the number of students in the group should be optimal, namely about 5 students, as this would guarantee positive outcomes. [YuW12].

Next, we present a model for the implementation of the project-based learning method at the Beihang University, namely for the Mechatronics course, where this method gives very good results. For the mechatronics course, at the beginning, the teacher presents the basic knowledge of mechatronics to form a certain knowledge base in the minds of the students, which can be used later in carrying out future tasks. This knowledge base is general and includes information on mechatronics, mechanisms, sensors, system management as well as process control. Then the practical part follows in which the students have to carry out a project proposed by the teacher and presenting applicability in mechatronics. After the teacher has proposed the project theme, the students begin to plan and design the project, analyzing the theories underlying it, designing the constructive scheme, simulating the whole assembly, doing the programming and the control of the system. Within this type of learning approach, students include the knowledge of mechanical design, microprocessor programming, signal processing, electrical circuits and other knowledge in order to achieve the project proposed by the teacher. In this case, the role of the teacher becomes a passive

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.













one, in the sense that he/she only has a supervisor and guide role in the second part of the course. Students are trained to develop skills and competencies for a thorough understanding of information and concepts, becoming active subjects in developing their own knowledge.

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.







Hochschule Kaiserslautern University of Applied Sciences Page | 22



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



6. Conclusions

In this Intellectual Output, a review and mapping of research related to peer to peer learning up to now was carried out. The carrying out of research in the educational field is an important component due to the necessity of the continuous renewal of the education system. The modern methods of teaching - learning - evaluation are student-centered and put the student in the foreground. They are focused on developing skills allowing the student to actively participate in the assimilation of information. In order to be able to picture the evolution in time of the peer to peer learning method and to identify the current stage in which this modern method is, we have proposed a diagram based on the scientific articles published every year since 1996 up to now. From this diagram, we observed that from year to year the number of articles increased and that this method is still in its development period. The most relevant articles according to the number of citations published about peer-to-peer learning were treated individually by identifying the key ideas in each article. Also, the advantages brought to individuals by peer-to-peer learning were identified from the information extracted from the most relevant scientific papers. Among the main advantages of this method, we can highlight: the development of organizational skills, of critical thinking and problem solving, of increased flexibility regarding interaction, as well as the decrease of stress and anxiety of individuals. Some specific characteristics of teaching in mechatronics as well as the treatment of the methods that gave good results were also identified. One of the methods is project-based learning which indeed experienced very good results. Next, what we are pursuing is that project-based methods developed in combination with innovative peer-to-peer learning methods will enhance the benefits of both individuals' learning and teachers' ways of teaching.

Acknowledgments

We thank Mrs. Julia Bogner and Prof. Dr. Gerd Bitsch at Hochschule Kaiserslautern – University of Applied Sciences for their expertise and support in writing this intellectual output.

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.













7. Bibliography

- [Alp05] S. E. Alptekin, D. DeTurris, D. J. Macy, J. E. Ervin, "Development of a flying eye: A project-based learning experience", Journal of Manufacturing Systems, vol. 24 no. 3, pp. 226-236, 2005 https://www.sciencedirect.com/science/article/pii/S0278612506800129
- [Ben17] B. A. Smallheer, E. Stone, J. Hicks, C. Galbreath, "Use of Video Recording to Facilitate Peer-to-Peer Learning in a Prelicensure Nursing Program", Teaching and Learning in Nursing, Vol. 12, no. 2, pp. 158-160, 2017 https://doi.org/10.1016/j.teln.2017.02.003.
- [Bor09] P. Bors, M. Dessauer, R. Bell, R. Wilkerson, J. Lee, S. L. Strunk, "The Active Living by Design National Program: Community Initiatives and Lessons Learned", American Journal of Preventive Medicine, vol. 37, no. 6(S2), pp. S313-S321, 2009 https://doi.org/10.1016/j.amepre.2009.09.027
- D. Boud, (2001). "Making the Move to Peer Learning" in Peer Learning in [Bou01] Higher Education: Learning from and with Each Other, D. Boud, R. Cohen and J. Sampson (Eds.), London: Kogan Page (now Routledge), 2001, pp. 1-20
- [Bou05] D. Boud, A. Lee, "'Peer learning' as pedagogic discourse for research education", Studies in Higher Education, vol. 30, no. 5, pp. 501-516, 2005 https://doi.org/10.1080/03075070500249138
- J. Broadbent, W. L. Poon, "Self-regulated learning strategies & academic [Bro15] achievement in online higher education learning environments: A systematic review", The Internet and Higher Education, vol. 27, pp. 1-13, 2015 https://doi.org/10.1016/j.iheduc.2015.04.007
- [Bul07] C. Bulte, A. Betts, K. Garner, S. Durning, "Student teaching: views of student near-peer teachers and learners", Medical Teacher, vol. 29, no. 6, pp. 583-590, 2009 https://doi.org/10.1080/01421590701583824
- S. Castelein, R. Bruggeman, L. Davidson, "Creating a Supportive Environment: [Cas15] Peer Support Groups for Psychotic Disorders", Schizophrenia Bulletin, vol. 41, no. 6, pp.1211–1213, 2015, https://doi.org/10.1093/schbul/sbv113

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.







Hochschule Kaiserslautern University of Applied Sciences





- [Che14] W. Chen, N. Zhendong, Z. Xiangyu, L. Yi, "A hybrid recommendation algorithm adapted in e-learning environments", World Wide Web, vol. 17, pp. 271–284, 2014 <u>https://doi.org/10.1007/s11280-012-0187-z</u>
- [Che19] C. H. Chen, Y. C. Yang, "Revisiting the effects of project-based learning on students' academic achievement: A meta-analysis investigating moderators", *Educational Research Review*, Vol. 26, pp. 71-81, 2019 <u>https://doi.org/10.1016/j.edurev.2018.11.001</u>
- [Dac15] L. Dache, S. F. Pop, Education, "Knowledge and Innovation from a Mechatronics Perspective", *Procedia - Social and Behavioral Sciences*, vol. 203, pp. 205-209, 2015 <u>https://doi.org/10.1016/j.sbspro.2015.08.283</u>
- [Dia14] D. Chen, Z. Li, T. Wang, "Exploration and practice: A competition based project practice teaching mode", *Mechatronics*, vol. 24, no. 2, pp. 128-138, 2014 <u>https://doi.org/10.1016/j.mechatronics.2013.12.009</u>
- [Dur17] C. Durose, C. Needham, C. Mangan, J. Rees, "Generating 'good enough' evidence for co-production", *Evidence & Policy*, vol 13., no 1, pp.135–51, 2017 https://doi.org/10.1332/174426415X14440619792955
- [Fis14] G. Fischer, "Beyond hype and underestimation: identifying research challenges for the future of MOOCs", *Distance Education*, vol. 35, no. 2, pp. 149-158, 2014
 https://doi.org/10.1080/01587919.2014.920752
- [Gra19] S. Gray, M. Wheat, M. Christensen, J. Craft, "Snaps⁺: Peer-to-peer and academic support in developing clinical skills excellence in under-graduate nursing students: An exploratory study", *Nurse Education Today*, vol. 73, 2019, pp. 7-12, 2019 https://doi.org/10.1016/j.nedt.2018.10.006
- [Har05] R. M. Harden, "A new vision for distance learning and continuing medical education", *Journal of Continuing Education in the Health Professions*, vol. 25, no. 1, pp. 43-51, 2005 https://doi.org/10.1002/chp.8
- [Hei19] S. Heidenreich, S. Breukers, "Who is telling whose story? The effectiveness of peer-to-peer approaches as inclusive participatory interventions towards

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.











sustainability", *Sustainable Production and Consumption*, vol. 21, pp. 216-227, 2020

https://doi.org/10.1016/j.spc.2019.10.001

- [Ion01] M. Ionescu, I. Radu, Didactica modernă, Editura Dacia, Cluj-Napoca, 2001 ISBN 973-35-1084-X
- [Iry19] Iryna Struk, Rivka Hellmann, Farhad Haeri, Roberta Calderon, Diamond Diaz, Gabrielle Senft, Collaborative peer to peer learning for shoulder ultrasound and anatomy, Journal of Interprofessional Education & Practice, Volume 14, 2019, Pages 39-42, ISSN 2405-4526, <u>https://doi.org/10.1016/j.xjep.2018.10.004</u>
- [Jac09] C. K. Jackson, C. K. E. Bruegmann, "Teaching Students and Teaching Each Other: The Importance of Peer Learning for Teachers", *American Economic Journal: Applied Economics*, vol. 1, no. 4, pp. 85-108, 2009 <u>https://doi.org/10.1257/app.1.4.85</u>
- [Joh07] D. W. Johnson, R. T. Johnson, K. Smith, "The state of cooperative learning in postsecondary and professional settings", *Educational Psychology Review*, vol. 19, pp. 15–29, 2007 https://doi.org/10.1007/s10648-006-9038-8
- [Kin98] A. King, A. Staffieri, A. Adelgais, "Mutual peer tutoring: Effects of structuring tutorial interaction to scaffold peer learning", *Journal of Educational Psychology*, vol. 90, no. 1, pp. 134-152, 1998 <u>https://doi.org/10.1037/0022-0663.90.1.134</u>
- [Kin99] King A., Discourse patterns for mediating peer learning. In A. M. O'Donnell & A. King (Eds.), Cognitive perspectives on peer learning, New York: Routledge, 1999, Ch. 4, pp. 87-115 <u>https://doi.org/10.4324/9781410603715</u>
- [Kno11] T. G. Knoot, M. Rickenbach, "Best management practices and timber harvesting: the role of social networks in shaping landowner decisions", Scandinavian Journal of Forest Research, vol. 26, no. 2, pp. 171-182, 2011 https://doi.org/10.1080/02827581.2010.545827
- [Kur02] T. Kurfess, W. Singhose, J. Fortgang, "Genesis and Evolution of an Undergraduate Mechatronics Course", *IFAC Proceedings Volumes*, vol. 35, no. 2, pp. 621-626, 2002
 <u>https://doi.org/10.1016/S1474-6670(17)34008-9</u>
- [Leh08] M. Lehmann, P. Christensen, X. Du, M. Thrane, "Problem-oriented and project-based learning (POPBL) as an innovative learning strategy for

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.







Hochschule Kaiserslautern University of Applied Sciences

Page | 26





sustainable development in engineering education", *European Journal of Engineering Education*, vol. 33, no. 3, pp. 283-295, 2008 https://www.tandfonline.com/doi/abs/10.1080/03043790802088566

- [Liu08] C. C. Liu, C. C Tsai, "An analysis of peer interaction patterns as discoursed by on-line small group problem-solving activity", *Computers & Education*, vol. 50, no. 3, pp. 627–639, 2008 <u>https://doi.org/10.1016/j.compedu.2006.07.002</u>
- [Nur17] N. Balta, N. Michinov, S. Balyimez, M. F. Ayaz, "A *meta*-analysis of the effect of Peer Instruction on learning gain: Identification of informational and cultural moderators", *International Journal of Educational Research*, vol. 86, pp. 66-77, 2017 https://doi.org/10.1016/j.ijer.2017.08.009
- [Pie15] D. M. Pietri, T. C. Stevenson, P. Christie, "The Coral Triangle Initiative and regional exchanges: Strengthening capacity through a regional learning network", *Global Environmental Change*, vol. 33, pp 165-176, 2015 <u>https://doi.org/10.1016/j.gloenvcha.2015.05.005</u>
- [Pin93] P. R. Pintrich, D. A. F. Smith, T. Garcia, W. J. Mckeachie, "Reliability and Predictive-Validity of the Motivated Strategies for Learning Questionnaire (MSLQ)", *Educational and Psychological Measurement*, vol. 53, no. 3, pp. 801-813, 1993 https://doi.org/10.1177/0013164493053003024
- [Pop14] S. F. Pop, "Cross-curricular Teaching Approaches Favouring the Active Learning of Mechatronics at Secondary Level", *Procedia - Social and Behavioral Sciences*, vol. 142, pp. 123-126, 2014 https://doi.org/10.1016/j.sbspro.2014.07.620
- [Ric09] M. Rickenbach, "Serving members and reaching others: The performance and social networks of a landowner cooperative", Forest Policy and Economics, vol. 11, no. 8, pp. 593–599, 2009 https://doi.org/10.1016/j.forpol.2009.08.006
- [Rob09] R. Clark, J. Andrews. (2009). "Peer Mentoring in Higher Education: A Literature Review", CLIPP working paper series; Vol. 0109. Birmingham (UK): Aston University, 2009 <u>https://research.aston.ac.uk/files/3003845/Peer_mentoring_in_higher_education_.pdf</u>
- [Sad14] G. Sadykova, "Mediating Knowledge through Peer-to-Peer Interaction in a Multicultural Online Learning Environment: A Case Study of International

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.











Students in the US", *The International Review of Research in Open and Distributed Learning*, vol. 15, no. 3, 2014 https://doi.org/10.19173/irrodl.v15i3.1629

- [Sun06] S. Sungur, C. Tekkaya, "Effects of problem-based learning and traditional instruction on self-regulated learning", *Journal of Educational Research*, vol. 99, no. 5, pp. 307-317, 2010 <u>https://doi.org/10.3200/JOER.99.5.307-320</u>
- [Top96] K. J. Topping, "The Effectiveness of Peer Tutoring in Further and Higher Education: A Typology and Review of the Literature"; *Higher Education*, vol. 32, no. 3, pp. 321-345, 1996
 <u>http://www.jstor.org/stable/3448075</u>
- [Top05] K. J. Topping, "Trends in Peer Learning", *Educational Psychology*, vol. 25, no. 6, pp. 631–645, 2005 https://doi.org/10.1080/01443410500345172
- [Yuw12] Y. Wang, Y. Yu, H. Wiedmann, N. Xie, C. Xie, W. Jiang, X. Feng, "Project based learning in mechatronics education in close collaboration with industrial: Methodologies, examples and experiences", *Mechatronics*, vol. 22, no. 6, pp. 862-869, 2012, <u>https://doi.org/10.1016/j.mechatronics.2012.05.005</u>
- [www01] web of science Query: https://wcs.webofknowledge.com/RA/analyze.do?product=WOS&SID= F4ZIMbWwiJtfBHigcHq&field=TASCA_JCRCategories_JCRCategories_en& yearSort=false

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.







Hochschule Kaiserslautern University of Applied Sciences