

Let us learn together!

Do complementary abilities foster pair collaboration in web-based learning?

Patricia Alves Rodrigues, Leônidas de O. Brandão
Computer Science Department
Institute of Mathematics and Statistics - USP
São Paulo, Brazil
{pati,leo}@ime.usp.br

Anarosa Alves Franco Brandão
Computing Engineering Department
Escola Politécnica - USP
São Paulo, Brazil
anarosa.brandao@poli.usp.br

Abstract— Information and Communication Technologies (ICT) are playing an increasing role in our daily lives and it is changing knowledge delivering. For engineers and related careers, where new trends and technologies are delivery continuously, having professional success depends on being updated with them. By adopting web-based learning so that both, students and professionals may accelerate such achievement. Nevertheless, the dropout rate of courses delivered by the World Wide Web (Web) used to be very high, mainly for the ones delivered by MOOC (Massive Open Online Courses). The reasons for that rely on several causes, mostly the ones related to the difficulty of students adapting themselves to the routine of individual studies. Therefore, finding strategies to deal with this difficulty may mitigate dropout rate in web-based learning. In this paper, we describe a systematic review of the literature to find evidences for the relevance of proposing a model to support web-based courses and foster collaboration between pairs as a mean to address the top three problems identified as reasons for the high dropout in distance learning. We also sketch iMPaCTS, the resulting model.

Keywords— *web-based learning; dropout; systematic review; pair collaboration; iMPaCTS.*

I. INTRODUCTION

The advances in *Information and Communication Technologies (ICT)*, associated with the specific evolution of technologies related to education, has leverage the usage of the distance learning modality. This movement has democratized the learning, turning knowledge accessible as has never been before. By using these technologies, several traditional educational institutions have started certificated courses under the modality of distance learning.

The last trend in this learning dissemination was the so - called *Massive Open Online Courses (MOOC)* [1]. They started in 2008 and became very popular after 2012 [2]. In this type of course, the content is available over the Web, the enrollment is free of charge and not limited. For this reason, a typical MOOC must be self-regulated, with no tutors.

Despite their growing presence, the literature has pointed out a critical question, the high dropout rate in courses delivered by the World Wide Web (Web) [3][4][5][6]. The reasons for that rely on several causes, mostly the ones related to the difficulty of students adapting themselves to the routine of individual studies [3][4][5][6]. Therefore, finding strategies to deal with this difficulty may mitigate dropout rate in distance learning, especially when considering MOOC as the modality for delivering distance learning. It is our claim that

when learners work together with someone who has complementary skills, the learners motivate themselves and produce better. In order to find evidences for such claim, which is perhaps the starting point of a research question and of a proposition of a model to support (web-based) learning based on pair collaboration, we had conducted a systematic review of the literature from the last 8 years.

The goal of a systematic review (SR) is providing a general view of an area or topic of investigation and determining evidences for the research based on wide scope exploratory questions [7][8]. The protocol to guide the SR, was composed of: (i) research question; (ii) search strategies; (iii) selection; and (iv) data extraction and analysis. Moreover, the SR was conducted iteratively, beginning with a wide scope question related to the dropout rate and its results guiding us to define a new question for which the protocol was applied and so on, until there was enough evidence to define iMPaCTS, a Model for Pair Collaboration Tool support. The steps to define the model are: (i) adapt an agile method to the process of teaching and learning through the Web; (ii) define a diagnosis technique to assess the knowledge and abilities of students; (iii) consider complementary knowledge, define a strategy for pair formation; and (iv) define the criteria for pair assessment. In this paper, we describe the systematic review and the collaboration model aforementioned.

II. CONDUCTING AN ITERATIVE SYSTEMATIC REVIEW

We have conducted a systematic review following an iterative approach to establish the basis for providing an approach to address the problem of high dropout rates in distance learning (DL) courses.

A protocol was defined to guide the review, and it was composed of: (i) research question; (ii) search strategies; (iii) selection criteria; and (iv) data extraction and analysis (see Fig. 1). Considering the iterative approach, the idea was running the protocol once for one general question and consider its results to guide the definition of new research questions to run the protocol again. This is repeated until no new relevant evidence was found.

The review was performed applying the protocol considering the following basis: IEEE Xplore, Google Scholar, Computers & Education (journal) and the Brazilian Committee of Informatics and Education related publications. Literature written in English and Portuguese were considered.

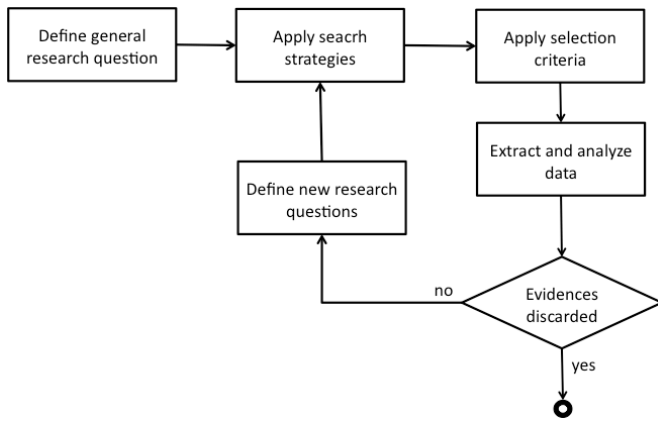


Fig. 1 Systematic Review: an iterative approach

A. Running the protocol

To search for the causes of high dropout in distance learning, the first research question (RQ1) we defined was a general one. Explicitly,

- RQ1: Which are the causes for high dropout in DL? What are the proposed solutions to deal with them?

Having defined RQ1, we started defining which search strategies must be carried on to find relevant literature on the theme. As a result, we decided to (i) conduct text mining within the repository of CEIE, the Special Committee for Informatics in Education of the Brazilian Computing Society; (ii) conduct searches within IEEEExplore and Google Scholar; (iii) conduct search within the Computers & Education journal. Moreover, we have established the years of 2008 to 2015 as time interval to conduct the search to recover updated research regarding the theme.

The CEIE repository is composed of publications related to the Brazilian Symposium on Informatics in Education, the Brazilian Journal on Informatics in Education and the Brazilian Workshop on Informatics in Education, most of these publications are written in Portuguese. Since we had established a time interval for mining the publications, we decided to locally import all the publications from the considered period and to conduct the text mining by using RapidMiner^B. There were 1995 publications to be mined and the software identified 29 that may be somehow relevant for RQ1.

For conducting the search in other basis, we extracted keywords, both in Portuguese and English, from RQ1 to define the search strings to be used in each base search engine to find the literature on the issue. Thus, the reference search string for RQ1 was ("*dropout rate*" AND ("*distance learning*" OR "*distance education*")).

As a result, Google Scholar recovered 8359 documents, IEEEExplore recovered 62 documents and Computers & Education recovered 60 documents. Having all the results from the first search strategy, we defined a process for selecting, extracting and analyzing the documents recovered, to find evidences that were applied to our problem.

A process for selecting and extracting which results from the text mining and the search engines may be relevant for our

research was defined and showed in Fig. 2. After applying the process, from CEIE, 24 were included and 14 were considered relevant; from Google, 50 were included and 37 were relevant; from IEEEExplore, 10 were included and 3 were relevant and, finally, from Computers & Education, 10 were included and 6 were relevant, totaling 60 relevant documents for RQ1.

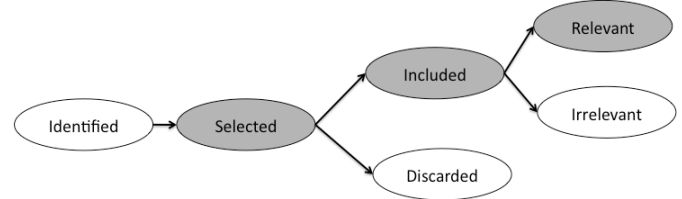


Fig. 2 Selection, Extraction and Analysis Process for the Systematic Review

In the selection, extraction and analysis process, where *identified* is all the results returned by RapidMiner or the search engines; *selected* is the top 5 publications according to the search engine relevance for each year of publication, or all if there were less than 5 results for that year. For text mining, all publications identified by RapidMiner were selected. The selected publications were analyzed according with their availability (if not available they were excluded from the list and the next one was considered) before reading their titles and abstracts to find some relation to RQ. The ones considered somehow related were included in our list and the others were discarded. All the included publications were entirely read and then we decided which ones were relevant. At the end of the process, out of the 94 publications included, 60 were considered as relevant for RQ1. After reading the 60 papers, we analyzed how RQ1 has been addressed in the last years.

The references that somehow addressed this question are: Almeida (2008) [9]; Almeida and Ildete (2008) [10]; Alves and Pereira (2012) [3]; Baggi and Lopes (2011) [4]; Bastos and Silva (2010) [11]; Bittencourt (2011) [12]; Bittencourt and Mercado (2013) [13]; Bruno-Faria e Franco (2012) [5]; Emanuelli (2011) [14]; Ferreira e Elia (2013) [15]; Hannum et al. (2008) [16]; Hoic-Bozic et al. (2009) [17]; Jensen e de Almeida (2009) [18]; Jorge et al. (2010) [19]; Laguardia e Portela (2009) [20]; Lykourantzou et al. (2009) [21]; Martins et al. (2012) [22]; Martins e Gebran (2013) [6]; Marinho et al. (2013) [23]; Mchichi et al. (2011) [24]; Lee and Choi (2011) [25]; Nichols (2010) [26]; Nistor and Neubauer (2010) [27]; Park and Choi (2009) [28]; Patterson and McFadden (2009) [29]; Pedroso et al. (2013) [30]; Pacheco et al. (2011) [31]; Pacheco et al. (2008) [32]; Pavanelli (2009) [33]; Roblyer e Davis (2008) [34]; Silva et al. (2012) [35]; Tao (2008) [36]; Wilges et al. (2010) [37]; Wingkvist and Ericsson (2012) [38]; Bentes and Kato (2014) [39]; Bittencourt and Mercado (2014) [40]; Braga et al. (2014) [41]; Cechinel et al (2015) [42]; Cornelio et al (2015) [43]; Cukusic et al (2014) [44]; Vieira (2015) [45]; Paschoalino et al (2015) [46]; Detoni et al (2014) [47]; Fernandes et al (2014) [48]; Gazza and Hunker (2014) [49]; Khali et al (2014) [50]; Lima and Junior (2015) [51]; Lucena et al (2015) [52]; Mauricio (2015) [53]; Deschacht and Goeman (2015) [54]; Oliveira (2014) [55]; Reino et al (2015) [56]; Ribeiro et al (2014) [57]; Rigo et al (2014) [58]; Santos et al (2014) [59]; Schlemmer (2015) [60]; Silva et al (2015) [61]; Tamariz and Souza (2015) [62]; Yukselturk et al (2014) [63].

^B <https://rapidminer.com>

Most of the work relies on analyzing the motives for the high dropout rates in distance learning. The frequent motives for dropout were mainly concerned to the lack of eye-to-eye contact with the teacher and the sensation of isolation; workload and deadlines; and personal problems, among others [12] [14] [20] [25] [64] [23] [39] [40] [47] [49] [50] [55] [58] [59] [41] [45] [51] [46] [56] [60]. We synthesized them in Table I, in the right columns is given the number of papers where the cause was cited and its associated percentage from the total that somehow address the issue. In addition, it is observed the occurrence of several researches on the identification of why learners give up the course and the means for preventing them from leaving the course before its end [21][22][27][28][34][35][37].

TABLE I. REASONS FOR THE DROPOUT.

Causes	#	%
Lack of face-to-face relationship between teacher and learners	31	52
Lack of contact with classmates (sensation of isolation)	26	43
Unsatisfactory tutoring (bad interactions and feedbacks)	26	43
Distance learning model adaptation	23	38
Lack of motivation	20	33
Technological problems (insufficient technical knowledge for using computers)	19	32
Personal problems (health, family, others)	18	30
Lack of time for studying	18	30
Low satisfaction level of the learner	15	25
Generic organization problems of classes (instructional design)	14	23
Lack of studying organization and no fulfillment of tasks deadlines	14	23
Financial problems	12	20
Professional problems or excessive working hours	10	17
Lack interactions with classmates or teacher	9	15
Difficulty in learning (Low effective performance)	9	15
Tasks complexity and cognitive overload level	8	13
Expression hardship on digital environments	7	12
Internet connection difficulties	7	12
Overload of activities during the course	6	10
Lack of administrative support	6	10
Demographic characteristics problems (age, sex, geographical location)	6	10
Lack of interest on contents	3	5
Lack of computer access	3	5
Material delivery problems	1	2
Software and hardware resources incompatibility	1	2
Excessive ease of activities	1	2
Lack of learner tenacity	1	2
Lack of library access	1	2

Considering the top three reported causes, the claim: working with someone who has complementary skills may motivate learners to produce better, should be further explored. Therefore, we have defined new research questions involving pair collaboration and pair evaluation in distance learning. The new RQs were:

- RQ2: What are the existing approaches to pair formation for collaborative learning in DL? Are the skills and knowledge of learners taken into account? If so, how?
- RQ3: What are the existing approaches for pair learning evaluation while adopting pairs for

collaborative learning in DL? Is individual learning taken into account? If so, how?

The protocol was ran again, considering as reference the search strings: ("*distance education*") AND ("*pairs training*" OR "*peer training*") for RQ2 and ("*peer evaluation*" OR "*evaluation by pairs*" OR "*pairs evaluation*") for RQ3.

The references that somehow addressed RQ2 are Mesquita (2008) [65], Müller and Silveira (2013) [66], Silva et al (2015) [67], Chagas 2014 [68]. For this question, the number of relevant results shows that the research on the adoption of pair collaboration in the distance-learning context is still in its infancy. Müller and Silveira present a report on using pairs in a collaborative system, where pairs are created considering similar profiles. Chagas proposes a system where pair formation is based on the knowledge similarities of the learners, while Silva et al. propose the adoption of a model for social combination to identify the pairs. In addition, Mesquita reports the use of pairs consisting of one local and one foreigner student to learn languages, and the sole criterion for pair formation was the origin of the students.

The references that somehow addressed RQ3 are Hayashi et al. (2013) [69]; Sirotheau et al. (2011) [70]; Ugolino et al. (2009) [71]; Deus (2012) [72]; Uchôa e Uchôa (2013) [73]; Lee (2009) [74]; Pereira e Figueiredo (2010) [75]; Lai et al. (2011) [76]; Kist e Brodie (2011) [77]; Mellati and Marzieh (2014) [78]; Marsico and Temperini (2014) [79]. Nevertheless, none of them presents an approach for pair learning evaluation.

At the end of second run of the protocol, from the 10 publications included, 04 were considered as relevant for RQ2 and from the 25 publications included, 11 were considered as relevant for RQ3.

After the results, we have evidence that the proposition of a model for pair collaboration, which is based on complementary cognitive abilities to support teaching and learning through the Web, may be a relevant strategy to deal with the top three dropout causes in distance learning courses. In addition, as agile methods are successfully adopted for pair collaboration while developing software, we have decided to search for any usage of agile methods to support learning activities. Another question (RQ4) was defined.

- RQ4: Are agile methods being adopted for teaching and/or learning issues different from software development? If so, what are they and how is it done?

The new protocol run was initiated considering (*teaching AND learning AND ("agile method" OR "agile methodology" OR "agile strategy" OR "agile approach")*) as the reference search string. The single reference that somehow addressed this question is Moraes et al. (2013) [80]. The SCRUM process [81] is adopted to propose means of self-regulated learning to learners. By self-regulated learning, they mean self-learning where the learner develops abilities related to autonomy, proactivity, organization and planning to self-regulate his/her own learning path.

After the third protocol run, from 41 documents included, only one was considered relevant. Thus, providing enough evidence that to propose a model based on pair collaboration to support teaching and learning through the web may be an interesting strategy to deal with the top three causes for the

high dropout rates in web-based courses. In addition, since existing work usually adopts similarities for identifying pairs, we decided to use complementarities for the same purpose. Also, since to evaluate knowledge acquisition one needs to assess the knowledge of the learners, a search was conducted for discovering what kind of metrics were adopted to perform the diagnosis and the formative evaluation in distance learning. The new question (RQ5) was defined.

- RQ5: What are the approaches for measuring the knowledge and skills of learners during the formative or diagnosis evaluation in DL?

The new protocol run was initiated considering the reference search string ("*distance education*") AND ("*diagnostic evaluation*" OR "*diagnostic assessments*" OR "*formative evaluation*" OR "*formative assessments*").

The results of the running consisted of 10 relevant documents, from the 50 included. They were: Araujo e Aranha (2013) [82]; Louzada et al. (2011) [83]; Nunes et al. (2013) [84]; Venancio e Lopes (2013) [85]; Lima (2008) [86]; Guan et al. (2013) [87]; Morais et al (2014) [88]; Kamardeen (2014) [89]; Oliveira (2015) [90]; and Baleni (2015) [91].

Venancio and Lopes provide a review of existing work related to how the evaluation is performed in the interactive learning environments in Brazil and they have concluded that the issue is still immature and deserves more research efforts. Araujo and Aranha considered formative evaluation as inherent by digital games. Lima proposes the definition of a Dependency Map to evaluate knowledge and skill while Guan and colleagues propose an adaptive algorithm for providing self-adaptive diagnosis and evaluation. Oliveira and Morais et al discuss the multidimensional character of knowledge evaluation. Kamardeen advocates that an integrated assessment scheme is essential in an educational setting for driving the student learning. Baleni suggests that the adoption of a formative assessment along the learning process could influence the achievements of the learners.

III. NEW FINDINGS AND INSIGHTS

Considering all the 220 papers analyzed, several (94) have discussed the reasons for the dropout rate in distance learning courses. Among the 94 papers, few were about dropout prediction. In fact, some of them discussed how to identify learners with some tendency to give up the course [21] [22] [26] [28] [34] [35] [37]. More recently, Educational Data Mining [47] [42] [58] [60] [63] is a trend for analyzing large amounts of data and finding ways to forecast when and why learners dropout.

Even more scarce was the usage of pairs and Agile approaches as a technique to organize and promote the educational path of learners in distance learning. Only one paper considered learning in pairs in non-related computing courses. There was no literature on using Agile methods to support learning activities in a general context of the distance learning.

Nonetheless, one work states that an agile approach is suitable for self-regulated learning [80], which is a form of learning similar to the one pursued while engaging in distance learning courses.

Moreover, it is well known that one of the pillars of the agile approaches is the work in pairs to develop software,

which has already been proved a successful way to foster collaboration during the development process. Therefore, the adoption of pairs to perform learning activities may profit from the use of an agile approach to foster collaboration between the pair.

Having these insights reinforced by the systematic review, we defined a model to support learning in pairs in a distance learning context. The steps to define the model are: (i) adapt an agile method to the process of teaching and learning through the web; (ii) define a diagnosis technique to assess the knowledge and abilities of students; (iii) consider complementary knowledge, define a strategy for pair formation; and (iv) define criteria for pair assessment. This model can be used to support general web-based learning contexts, including MOOCs.

IV. IMPACTS: A MODEL FOR PAIR COLLABORATION TOOL SUPPORT

The aim of the model is to reduce the sense of isolation of the learners in distance learning education, and increase their motivation to follow the course. This model promotes pair formation in a complementary basis considering the knowledge and characteristics of each pair member. Besides, it adopts the agile method Scrum to stimulate collaboration between learners.

It is called iMPaCTS for emphasizing the use of the web as an interactive environment to support learning through pair collaboration. It is composed of 3 modules: (i) pre-learning; (ii) pair learning; and (iii) post-learning. The basis for the model is the learning unit (LU), which represents the fine grained unit that composes a course (or discipline).

The pre-learning module is responsible for evaluating the knowledge level of the learner concerning some LUs, prior to her/his engagement in the pair learning. This evaluation can be performed by using questionnaires. This information will be stored in a proficiency database.

The proficiency database general model is a table with attributes by rows and criteria by columns. This allows a very flexible model, where the teacher can vary the criteria in accordance with the activity or subject under focus. It is also possible to add new criteria (columns), allowing the evolution of the model. In addition, the proficiency database may be initially populated by reusing the learner information from previous courses that were already available in the system. Nevertheless, an ontology may be used to provide interoperability with other systems.

The learning pair is the main module of iMPaCTS. It is responsible for pair formation, fostering collaborative learning and providing the formative evaluation, for each course LU. For each LU, learners are grouped in pairs, which are defined in accordance with the proficiency database. Currently, pair formation is performed by the system taking into account the prerequisites of the LU, selecting the convenient rows from the proficiency table.

The matching is performed taking into account the abilities and knowledge of learners, in a manner in which the pair would be complementary. For instance, considering two attributes, X and Y, learners A and B may form a pair if A has a weak score in attribute X and a high score in Y, while B has

the opposite. This is the starting point to foster pair collaboration.

During the evolution of the course, the proficiency database is dynamically updated with the information sourced from the formative evaluation after finalizing each LU. For this reason, if a new LU is to be initiated, with the same set of prerequisites, the pair matching could be very different. As a result, proficiency database of this module is the changes in the columns from the proficiency table.

The post-learning module is responsible for evaluating the knowledge level of the learner concerning some LUs, after her/his engagement in the pair learning and the finalization of the activities proposed in a LU. This evaluation may be performed by summative evaluation, which considers learner proficiency during pre-learning and her/his evolution throughout the LU execution. This information will update the proficiency database by revising the attributes of the proficiency table, i.e., by changing its rows. For instance, the analysis could suggest new attributes or the replacement of one coarse-grained attribute by fine-grained ones. A general view of the model is presented in Fig. 3.

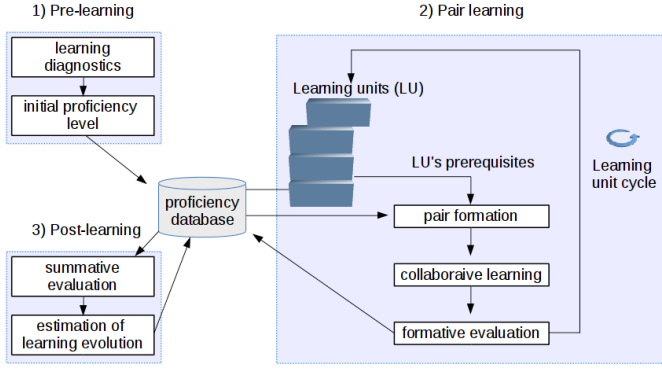


Fig. 3 iMPaCTS general view

A. The Pair Learning Module

Considering the role of the Pair Learning Module in iMPaTCS, a description of how it is organized and implemented is given by using a component-based approach. This should enable the introduction of several criteria for pair formation, which is a sensitive aspect of the model.

Therefore, a kernel for pair formation should be defined and the introduction of new strategies or criteria for pair formation may be achieved by simply plugging in a component containing their implementation to its kernel. Nevertheless, the same is valid for the strategies for fostering pair collaboration or providing the formative evaluation.

For validating the model, we described only one criterion for pair formation, as well as for fostering pair collaboration and providing formative evaluation.

A. Pair formation criteria

The first implementation of pair formation adopts the Pearson correlation coefficient [92] as the criteria for choosing the members of a pair. This coefficient is a statistical metric for analyzing the linear correlation (dependence) between two random variables, with the variation range of $[-1,1]$. The closer to 1 (or to -1) the coefficient is, the more dependent the variables are. A positive correlation means that both either increase (or decrease) together and a negative correlation

means that the variables present opposite behavior. On the contrary, the closer to 0 the correlation is, the more independent the variables are.

Thus, as we are interested in the complementary knowledge and skills for composing the pair, the idea is to associate with each learner a table of proficiency by subject (or LU). This table contains proficiency values that will be used to find another learner who presents negative correlation with them.

B. Pair collaboration

In order to foster collaboration between pairs, we have adapted the agile method Scrum, which resulted in the *Scrum Method for Learning (SML)*. The SML has an iterative and incremental life cycle, as the original Scrum method [93]. By life cycle, we mean the time during which a LU is executed.

The roles of "product owner", "Scrum master" and "team" used in the Scrum methods are played in SML by the teacher, some system features and learners, respectively. Therefore, as "product owners", teachers are responsible for (i) determining course pre-requisites; (ii) defining the LU of the course and its associate release date; (iii) taking part during interaction meetings; (iv) keeping the learners working.

In Scrum, the "scrum master" is responsible for (i) allowing the collaboration between all players; (ii) removing impediments and avoiding distraction in the team; (iii) ensuring that the team will follow the agile rules, including daily meetings (*stand-ups*) and other meetings (planning, demos, revision, and retrospective); (iv) facilitating team meetings and decision meetings. In our case, system features will fulfill such responsibilities by (i) providing an area for collaborative work; (ii) arranging an area for meeting sessions; (iii) providing warnings with some helping recommendation; and (iv) reporting learner performance.

In the traditional Scrum, the team is responsible for turning the list of requirements into delivered products. In SML, the role "team" is played by pairs of learners. Eventually, one team will have three learners. The team will organize itself and the learning process.

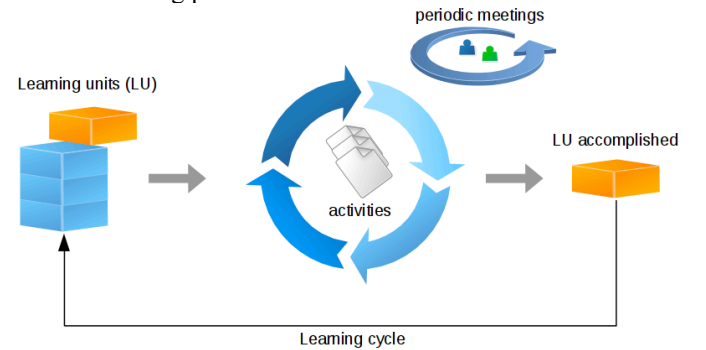


Fig. 4 SML: an adaptation of SCRUM to the learning process

The SML process describes an iterative learning cycle where a course is composed of several LUs and each of them is processed during one SML cycle. The matching with SCRUM is a LU in SML is a *sprint* in SCRUM. Therefore, teachers fix the time for the LU to be completed and, at the beginning, planning meetings take place, involving teacher and pairs of learners to establish learning objectives.

The pairs start working on the LU activities and attend periodic meetings that may involve other pairs or the teacher.

After completing all LU activities, the cycle is completed with the evaluation of the results obtained by each pair. A general view of the process is presented in Fig 4.

C. Pair evaluation

During the learning cycle of SML, several activities are conducted individually, but with pair collaboration. The formative evaluation of each learner is dynamically built during the cycle and it is finalized for each LU. This evaluation will be used to update the proficiency of learners in LU.

V. CONCLUSION AND FUTURE WORK

We described an iterative systematic review of the literature conducted to confirm that the proposition of a model for pair collaboration to support web-based teaching and learning activities may be an interesting strategy to deal with the high dropout rates of web-based courses. In addition, we have presented iMPaCTS, a model for pair collaboration in distance learning environments. The underlying idea of providing pair collaboration is increasing motivation and decreasing dropout among learners who are engaged in distance learning courses. We believe that this modality of learning will continue to grow considering the number of delivered courses and engaged learners.

Prior the definition of the model, we delineated some research questions to guide the review and the results show that several researches are concerned with the high dropout rate in distance learning. Furthermore, some solutions for preventing it have been addressed, but most of them are related to the identification of dropout candidates instead of trying to motivate them from the beginning of their engagement in a course. In addition, although the adoption of an agile approach was pointed as suitable for self-regulated learning, no work on employing such approaches to support distance learning activities were found. Increasing motivation and production by working in pairs is a reality in software development using agile approaches and the review showed that the adoption of the same idea for promoting learning may be interesting.

iMPaCTS is composed of three modules, pre-learning, pair learning and post-learning, and a proficiency database. By defining the pre and post-learning modules, we created means for populating and updating the proficiency database to establish criteria for pair formation considering, for instance, complementary abilities related to a learning unit.

The model allows flexibility to define strategies for pair formation, as well as the manner in which collaboration would be fostered between pairs and the process by which formative evaluation will be built.

The model validation is out of the scope of this paper and will be subject of further consideration. Currently, we have started defining a series of experiments to analyze the model efficacy on increasing motivation and decreasing dropout in distance learning courses. For that, we are implementing iMPaCTS as described here as a Moodle module. Having such implementation will allow us to run experiments for small, medium and large scale web-based learning contexts. After finalizing the experiments, we intend to implement new strategies for pair formation and formative evaluation.

References

- [1] Seaton, D. T., Bergner, Y., Chuang, I., Mitros, P., Pritchard, D. E. "Who Does What in a Massive Open Online Course? (MOOCs)". *Communications of the ACM*, vol. 57, issue 4, April 2014.
- [2] Parr, C. "Mooc creators criticise courses' lack of creativity". *Times Higher Education* 17.03 (2013): 2013.
- [3] Alves, A. P. V. and Pereira, S. B. S. "A evasão escolar na modalidade de ensino a distância: o polo presencial de itapemirim-ES". *Anais do SIED: EnPED-ISSN 2316-8722*, 1(1), 2012.
- [4] Baggi, C. A. S. and Lopes, D. A. "Evasão no ensino superior: um desafio para a avaliação institucional?", 2011.
- [5] Bruno-Faria, M.F. and Franco, A. L. "Causas da evasão em curso de graduação a distância em administração em uma universidade pública federal". *Teoria e Prática da Educação*, 14(3), 43-56, 2012.
- [6] Martins, C.Z. and Gebran, R.A. "As causas da evasão discentes na educação a distância na perspectiva dos tutores". II Congresso Internacional sobre desenvolvimento social 2013.
- [7] Kitchenham, B. "Procedures for performing systematic reviews". *Keele, UK, Keele University*, 33, 1-26, 2004.
- [8] Kitchenham, B. and Charters, S. "Guidelines for performing systematic literature reviews in software engineering", 2007.
- [9] Almeida, O. C. S. "Evasão em cursos a distância: análise dos motivos de desistência", 2008.
- [10] Almeida, I. C., Ildete, M. "Educação Continuada em Geral. Educação a distância: Um estudo dos motivos de desistência de um curso a distância via internet". *Associação Brasileira de Educação a Distância. Trabalhos científicos*, 2008.
- [11] Bastos, H. P. P. and Silva, J. M. "Fatores de evasão em curso a distância: Relato de pesquisa sobre evadidos do curso leitura instrumental em inglês a distância no IFF-RJ". *RENTE*, 7(3): 64-72 (2010).
- [12] Bittencourt, G. P. "Evasão na educação a distância do ensino superior: estudo de caso no 1º curso de administração EAD da UFRGS". *Universidade Federal do Rio Grande do Sul. Escola de Administração. Curso de Administração*, 2011.
- [13] Bittencourt, I. M. and Mercado, L. P. L. "Problemas endógenos como principal causa de evasão do curso piloto de administração a distância da UFAL/UAB", 2013.
- [14] Emanuelli, G. B. "Atração e refração na educação a distância: constatações sobre o isolacionismo e a evasão do aluno". *Revista Gestão Universitária na América Latina-GUAL*, 4(2):205-218, 2011.
- [15] Ferreira, V.S. and Elia, M. F. "Uma modelagem conceitual para apoiar a identificação das causas da evasão escolar em EAD". *Em Anais do Workshop de Informática na Escola*, volume 1, 2013.
- [16] Hannum, W. H., Irvin, M. J., Lei, P. W. and Farmer, T. W. "Effectiveness of using learner-centered principles on student retention in distance education courses in rural schools". *Distance Education*, 29(3), 211-229, 2008.
- [17] Hoic-Bozic, N., Mornar, V. and Boticki, I. (2009). "A blended learning approach to course design and implementation". *Education, IEEE Transactions on*, 52(1), 19-30, 2009.
- [18] Jensen, L. F. and Almeida, O.C. S. "A correlação entre falta de interatividade e evasão em cursos a distância". In *Anais: XV Congresso Internacional de Educação a Distância*, 2009.
- [19] Jorge, B.G., Martins, C. Z., Carniel, F., Lazilha, F. R., Vieira, M. C., Goi, V. M. and Pesquisa, C. "Evasão na educação a distância: um estudo sobre a evasão em uma instituição de ensino superior". *Maringá: abril*, 2010.
- [20] Laguardia, J. and Portela, M. "Evasão na educação a distância Dropout in distance education". *ETD-Educação Temática Digital*, 11(1), 349-379, 2009.
- [21] Lykourantzou, I., Giannoukos, I., Nikolopoulos, V., Mpardis, G. and Loumos, V. "Dropout prediction in e-learning courses through the combination of machine learning techniques". *Computers & Education*, 53(3), 950-965, 2009.

- [22] Martins, L. C., Lopes, D. A. and Raabe, A. "Um Assistente de Predição de Evasão aplicado a uma disciplina Introdutória do curso de Ciência da Computação". In Anais do Simpósio Brasileiro de Informática na Educação, 23(1), 2012.
- [23] Marinho, S. P. P., Ishitani, L., Marinho, A. M., da Silva, C. L., Santos, G. J., Peret, L. and Araújo, P. M. C. "A evasão na formação on-line no projeto uca em minas gerais: identificar razões para pensar novas estratégias". In Anais dos Workshops do Congresso Brasileiro de Informática na Educação, 2(1), 2013.
- [24] Mchichi, T., Estrailier, P. and Afdel, K. "Web 2.0 based e-learning: Moodle-openmeetings platform". In Multimedia Computing and Systems (ICMCS), International Conference on (pp. 1-6). IEEE, 2011.
- [25] Lee, Y. and Choi, J. "A review of online course dropout research: implications for practice and future research". Educational Technology Research and Development, 59(5), 593-618, 2011.
- [26] Nichols, M. "Student perceptions of support services and the influence of targeted interventions on retention in distance education". Distance Education, 31(1), 93-113, 2010.
- [27] Nistor, N. and Neubauer, K. "From participation to dropout: Quantitative participation patterns in online university courses". Computers & Education, 55(2), 663-672, 2010.
- [28] Park, J. H. and Choi, H. J. "Factors Influencing Adult Learners' Decision to Drop Out or Persist in Online Learning". Educational Technology & Society, 12(4), 207-217, 2009.
- [29] Patterson, B. and McFadden, C. "Attrition in online and campus degree programs". Online Journal of Distance Learning Administration, 12(2), 2009.
- [30] Pedroso, C. B., Maracci, F. V., Kunze, W. L. and Rizo, C. M. "Hipermidia adaptativa e a evasão na educação a distância". In Colloquium Exactarum. 5 (2), 01-11, 2013.
- [31] Pacheco, A. S. V., Nakayama, M. K., Spanhol, F. J., Rissi, M., Pacheco, A. S. V., and Costa, A. M. "Evasão e permanência dos estudantes de um curso de administração do sistema universidade aberta do Brasil: uma teoria multiparadigmática". III Encontro de Ensino e Pesquisa em Administração e Contabilidade, 2011.
- [32] Pacheco, A. S. V., Nakayama, M. K., Spanhol, F. J., Melo, P. A., Rissi, M., Benetti, K. C. and Soares, A. P. "Fatores dificultadores à permanência dos alunos no curso de graduação em administração a distância da Universidade Federal de Santa Catarina". *RENOTE*, 6(1), 2008.
- [33] Pavanelli, G. "Gestão em educação a distância e fatores determinantes de evasão", 2009.
- [34] Roblyer, M. D. and Davis, L. "Predicting success for virtual school students: Putting research-based models into practice". Online Journal of Distance Learning Administration, 11(4), 2008.
- [35] Silva, J. K. K., Bastos, H. P. P., Bercht, M. and Wives, L. K. "Automatização do processo de identificação de presença social em fóruns e chats". In Anais do Simpósio Brasileiro de Informática na Educação, volume 23, 2012.
- [36] Tao, Y.. "Typology of college student perception on institutional e-learning issues - an extension study of a teacher's typology in taiwan". *Computers & Education*, 50(4):1495 -1508. ISSN 036
- [37] Wilges, B., da Costa Ribas, J. C., Catapan, A. H. and Bastos, R. C. "Sistemas multiagentes: mapeando a evasão na educação a distância". *RENOTE*, 8(1), 2010.
- [38] Wingkvist, A. and Ericsson, M. "Introducing podcasts to the educational palette of a dual-mode course". Em Wireless, Mobile and Ubiquitous Technology in Education (WMUTE), 2012 IEEE Seventh International Conference on, páginas 112-116, 2012.
- [39] Bentes, Márcia Cristina Benigno, and Olívia Misae Kato. "Fatores que afetam a evasão na educação a distância: curso de administração." *Psicol. educ* 39 (2014): 31-45.
- [40] Bittencourt, I. M., and Mercado, L. P. L. (2014). "Evasão nos cursos na modalidade de educação a distância: estudo de caso do Curso Piloto de Administração da UFAL/UAB". *Revista Ensaio: Avaliação e Políticas Públicas em Educação*, 22(83), 465-504.
- [41] Braga, M., Takimoto, T., Silva, D., Júnior, O. D. G. F., and Barros, P. A. M. (2015). "Estratégias para Incentivar la Participación de Alumnos en Educación a Distancia". In Anais do Simpósio Brasileiro de Informática na Educação (Vol. 26, No. 1, p. 101).
- [42] Cechinel, C., Araújo, R. M., and Detoni, D. "Modelagem e Predição de Reprovação de Acadêmicos de Cursos de Educação a Distância a partir da Contagem de Interações". *Revista Brasileira de Informática na Educação*, 23(03), 1, 2015
- [43] Cornelio, R. A., Vasconcelos, F. C. W., And Goulart, I. B. "Educação A Distância: Uma Análise Estatística Dos Fatores Relacionados À Evasão E À Permanência", 2015.
- [44] Ćukušić, Maja, Željko Garača, and Mario Jadrić. "Online self-assessment and students' success in higher education institutions." *Computers & Education* 72 (2014): 100-109.
- [45] de Freitas Vieira, M. "Desafios na gestão de EaD no contexto dos polos de apoio presencial da Universidade Aberta do Brasil. Discutindo a visibilidade da EaD Pública no Brasil", 74, 2015.
- [46] de Queiroz Paschoalino, J. B., Campos, F. A. C., Viana, I. S., and Fidalgo, F. S. R. "EAD entre os ditames legais e a realidade concreta". *Revista Brasileira de Informática na Educação*, 23(01), 13, 2015.
- [47] Detoni, D., Araújo, R. M., and Cechinel, C. "Predição de Reprovação de Alunos de Educação a Distância Utilizando Contagem de Interações". In Anais do Simpósio Brasileiro de Informática na Educação, vol. 25(1), p. 896, 2014.
- [48] Fernandes, J., da Silva Ferreira, A., de Oliveira Nascimento, D. C., Shimoda, E., and Teixeira, G. F. "Identificação de Fatores que Influenciam na Evasão em um Curso Superior de Ensino a Distância". *PerspectivasOnLine 2007-2010*, 4(16), 2014.
- [49] Gazza, Elizabeth A., and Diane F. Hunker. "Facilitating student retention in online graduate nursing education programs: A review of the literature." *Nurse education today* 34.7 (2014): 1125-1129.
- [50] Khalil, H. and Ebner, M. "MOOCs Completion Rates and Possible Methods to Improve Retention - A Literature Review". In J. Viteli and M. Leikomaa (Eds.), *Proceedings of EdMedia: World Conference on Educational Media and Technology 2014* (pp. 1305-1313). Association for the Advancement of Computing in Education (AACE), 2014.
- [51] Lima, E. S., and Junior, J. B. B. "Revisão Sistemática da Literatura: as causas da evasão nos cursos de Graduação a Distância/Systematic Literature Review: the evasion causes in undergraduate distance courses". *Revista EducaOnline*, 9(3), 32-69, 2015.
- [52] Lucena, K. T., Silva, J., and Oliveira, E. "WebMonitor: uma ferramenta para monitoramento e acompanhamento de cursos em um AVA". In Anais do Simpósio Brasileiro de Informática na Educação, vol. 26, No. 1, p. 249, 2015.
- [53] Maurício, Wanderléa Pereira Damásio. "De uma educação a distância para uma educação sem distância: a problemática da evasão nos Cursos de Pedagogia a distância.". Tese.Universidade do Vale do Rio dos Sinos, 2015.
- [54] Deschacht, N., Katie Goeman. "The effect of blended learning on course persistence and performance of adult learners: A difference-in-differences analysis". *Computers & Education*, Volume 87, September 2015, Pages 83-89, ISSN 0360-1315.
- [55] Oliveira, José Renato Gomes (2014). "Nenhum A Menos: O Problema Da Evasão Na Educação A Distância.". In anais XI ESUD - Congresso Brasileiro de Ensino Superior a Distância.
- [56] Reino, L. R. A. C., Hernández-Domínguez, A., Júnior, O. D. G. F., Carvalho, V. D. H., Barros, P. A. M., & de Melo Braga, M. "Análise das Causas da Evasão na Educação a Distância em uma Instituição Federal de Ensino Superior", 2015.
- [57] Ribeiro, G. O., Silva, T. E., Nunes, A. O., Pinto, F. A. P., and Vasconcelos, F. H. L. "Perspectivas para a Redução da Evasão em EaD a partir da Avaliação da Qualidade do Ensino Online". In Anais do Workshop de Informática na Escola, vol. 20, No. 1, p. 428, 2014.
- [58] Rigo, S. J., Cambuzzi, W., Barbosa, J. L., and Cazella, S. C. "Aplicações de Mineração de Dados Educacionais e Learning Analytics com foco na evasão escolar: oportunidades e desafios". *Revista Brasileira de Informática na Educação*, 22(01), 132, 2014.
- [59] Santos, F. M. L. N., Teles, F. M. C., and Veríssimo, P. D. "Evasão na educação a distância: um estudo da evasão na escola de gestão pública do estado do CEARÁ-EGP", 2014.

- [60] Schlemmer, Eliane. "Estratégias para minimizar a evasão na educação a distância: o uso de um sistema de mineração de dados educacionais e learning analytics", 2015.
- [61] Silva, F., da Silva, J., Silva, R., and Fonseca, L. C. "Um modelo preditivo para diagnóstico de evasão baseado nas interações de alunos em fóruns de discussão". In Anais do Simpósio Brasileiro de Informática na Educação, vol. 26, No. 1, p. 1187, 2015.
- [62] Tamariz, Annabell Del Real, and Marcos de Souza. "Educação a Distância no Brasil: perspectivas para redução na evasão de alunos matriculados." *Educação 5.1* (2015): 227-253.
- [63] Yukselturk, Erman, Serhat Ozekes, and Yalin Kılıç Türel. "Predicting dropout student: an application of data mining methods in an online education program." *European Journal of Open, Distance and e-Learning 17.1* (2014): 118-133.
- [64] Leite, E. A., Sales, G. L., Lima, H. V. and Aguiar, E. P. "Reestruturação do Curso de Formação em Conselhos Escolares no AVA Moodle por meio do Design Instrucional". In Anais do Workshop de Informática na Escola.1(1), 2013.
- [65] Mesquita, A. A. F. D. "Crenças e práticas de avaliação no processo interativo e na mediação de um par no tandem a distância: um estudo de caso". Phd thesis, Paulista State University, 2008.
- [66] Müller, L. and Silveira, M. S. "Podes me ajudar? Apoiando a formação de pares em sistemas de ajuda em pares através de técnicas de recomendação". In Anais do Simpósio Brasileiro de Informática na Educação, 24 (1), 2013.
- [67] Silva, Soraia Pacheco, Carlo Emmanoel Tolla de Oliveira, and Claudia Lage Rebello da Motta. "Promovendo a aprendizagem através das redes sociais apoiada por um modelo de combinação social." *Revista Brasileira de Informática na Educação 23.01* (2015): 122.
- [68] Chagas, Lucinéia Barbosa Da Costa. "Um ambiente para aprendizagem de programação com o uso de arquiteturas pedagógicas". Dissertação (Mestrado em Informática) - Universidade Federal do Espírito Santo, Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, 2014.
- [69] Hayashi, E, Posada, J. E. G., and Baranauskas, M. C. C. "Explorando princípios de afetividade no redesign de aplicações para contextos educacionais". In Anais do Simpósio Brasileiro de Informática na Educação, volume 24, 2013.
- [70] Sirotheau, S., Brito, S. R., Silva, A. S., Eliasquevic, M. K., Favero, E. L. and e Tavares, O. L. "Aprendizagem de iniciantes em algoritmos e programação: foco nas competências de autoavaliação". In Anais do Simpósio Brasileiro de Informática na Educação, volume 1, 2011.
- [71] Ugulino, W., Marques, A. D. M., Pimentel, M. and Siqueira, S. W. "Avaliação Colaborativa: um Estudo com a Ferramenta Moodle Workshop". XX Simpósio Brasileiro de Informática na Educação, Universidade Federal de Santa Catarina, Florianópolis, 2009.
- [72] Deus, L. C. J. "Modelo de plataforma conectivista para apoio a aprendizagem socializada". MSc dissertation . Departamento de Ciência da Computação do Instituto de Matemática. Universidade Federal do Rio de Janeiro, 2012.
- [73] Uchôa, K. C. A. and Uchôa, J. Q. "Uma Análise Sobre Avaliação Colaborativa em Fóruns de Discussão". *RENOTE*, 10(3), 2013.
- [74] Lee, H. "Peer evaluation in blended team project-based learning; what do students find important?" In World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education, pp 2838-2842, 2009.
- [75] Pereira, I. and Figueiredo, A. D. "Promoting motivation and participation in higher education: a b-learning experience". In Frontiers in Education Conference (FIE), 2010 IEEE (pp. SIC-1). IEEE.
- [76] Lai, F. Q., Snapp, K. and Burk, C. "Online Peer Evaluation as an Assessment and Collaborative Learning Approach: Perspectives from Two Students". In Society for Information Technology & Teacher Education International Conference, v. 1, 437-441, 2011.
- [77] Kist, A. A. and Brodie, L. "SPIDER activities: select, prepare and investigate, discuss, evaluate, reflect". In Global Engineering Education Conference (EDUCON), 2011 IEEE (pp. 498-504). IEEE.
- [78] Mellati, Morteza, and Marzieh Khademi. "Peer Evaluation in CMC Learning Environment and Writing Skill." *International Journal of Applied Linguistics and English Literature 3.5* (2014): 220-228.
- [79] Marsico, M. D., A. Sterbini and M. Temperini, "Experimental Evaluation of Open Answer, a Bayesian Framework Modeling Peer Assessment," 2014 IEEE 14th International Conference on Advanced Learning Technologies, Athens, 2014, pp. 324-326.
- [80] Moraes, M. A. C. D., Borges, K. S. and Okuyama, F. "Autorregulação da aprendizagem em computação com apoio da metodologia Scrum". *Texto Livre: Linguagem e Tecnologia*, 6(2), 2013.
- [81] Schwaber, K. "Agile project management with Scrum". Microsoft Press, 2004.
- [82] Araujo, G. and Aranha, E.H.S. "Avaliação formativa da aprendizagem com instrumentação em jogos digitais: Proposta de um framework conceitual". Em Anais dos Workshops do Congresso Brasileiro de Informática na Educação, volume 1. 2013.
- [83] Louzada, A., Elia, M.F.; Ferrentini Sampaio, F.; Vidal, A.L.P. and Rodrigues, R. Validação de um modelo de avaliação no uso da modelagem computacional em atividades educacionais. Em Anais do Simpósio Brasileiro de Informática na Educação, volume 1. 2011.
- [84] Nunes, E., Testa, R.L. and Nunes, F.L.S.. "Sistema de coleta de dados para avaliação da aprendizagem em ambientes virtuais de aprendizagem tridimensionais". Em Anais dos Workshops do Congresso Brasileiro de Informática na Educação, volume 1. 2013.
- [85] Venancio, V. and Lopes, R. D.. Avaliação da aprendizagem em sistemas interativos: uma revisão comparativa focada no sbie, wie e wavalia. Em Anais do Simpósio Brasileiro de Informática na Educação, volume 24, 2013.
- [86] Lima, L. "A aprendizagem significativa do conceito de função na formação inicial do professor de matemática". MSc dissertation, State University of Ceará, 2008.
- [87] Guan, M., Jia, J., Yang, Y., Hua, Y. and Chen, Q. "Research on adaptive e-Learning system using technology of learning navigation". In Computer Science & Education (ICCSE), 2013.
- [88] Moraes, Alana M., Joseana MFR de Araújo, and Evandro B. Costa (2014). "Arcabouço Multidimensional de Avaliação dos Discentes baseado na Análise de Recursos Pedagógicos." XXII Workshop sobre Educação em Informática - 2014 - Brasília, DF.
- [89] Kamardeen, Imriyas. "Stimulating learning with integrated assessments in construction education." *Construction Economics and Building 14.3* (2014): 86-98.
- [90] de Oliveira, Gerson Pastre. "Colaboração e multidimensionalidade como elementos para a avaliação da aprendizagem em cursos on-line." *Revista de Ciências Exatas e Tecnologia 2.2* (2015): 30-37.
- [91] Baleni, Zwelijongile Gaylard. "Online Formative Assessment in Higher Education: Its Pros and Cons." *Electronic Journal of e-Learning 13.4* (2015): 228-236.
- [92] Pearson, K. "Notes on regression and inheritance in the case of two parents" *Proceedings of the Royal Society of London*, 58: 240-242. 1895.
- [93] Neto, E. I. "Ferramenta Educacional para Ensino de Práticas do SCRUM", 2008.