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articoli

Feedback with technologies in higher education: a systematic review

Il feedback con le tecnologie all'università: una rassegna sistematica

Chiara Laici[a], Maila Pentucci[b,1]

[a] Università degli Studi di Macerata, chiara.laici@unimc.it
[b] Università degli Studi di Macerata, maila.pentucci@unimc.it

Abstract

This contribution is a systematic review of the literature concerning the activation of feedback processes in university classes through the use of different types of Student Response Systems. The nine articles selected through the search aim at making more complex feedback procedures emerge, both multi-dimensional and multidirectional, transformative, not only in comparison to learning, but also to the learning design. Recursive feedback strategies through technologies are more difficult to realise and need complex training ecosystems, which are structured starting from valid pedagogic requirements and have been scientifically validated. They need active didactic strategies involving the students alongside the action. They are effective, not only in improving the practice and decreasing the transmissive dimension of university didactics, but also in structuring true dialogic postures between students and instructors, leading to a co-designing of the learning-teaching paths, to the alignment of the objectives, and to a co-structuring of new knowledge outcomes.

Keywords: feedback; student response system; higher education; educational technologies.

Sintesi

Il contributo presenta una review sistematica della letteratura riguardante l'attivazione di processi di feedback nelle aule universitarie, attraverso l'utilizzo di Student Response Systems di varia tipologia. I nove articoli selezionati attraverso la ricerca puntano a far emergere procedure di feedback più complesse, multidimensionali e multidirezionali, trasformative non solo rispetto agli apprendimenti ma anche al learning design. Strategie di feedback ricorsivo attraverso le tecnologie sono più difficili da attuare e necessitano di ecosistemi formativi complessi, strutturati a partire da presupposti pedagogici fondati e scientificamente validati. Esse risultano efficaci non solo al fine di migliorare le pratiche e diminuire la dimensione trasmissiva della didattica universitaria, ma anche per strutturare vere e proprie posture dialogiche tra studenti e docenti che conducano ad una co-progettazione dei percorsi di insegnamento-apprendimento, all'allineamento degli obiettivi e ad una co-strutturazione di nuovi costrutti di sapere.

Parole chiave: feedback; student response system; didattica universitaria; tecnologie didattiche.

[1] Chiara Laici is the author of paragraphs 3, 4, 5.1. Maila Pentucci is the author of paragraphs 1, 2, 5.2., and paragraphs 6 is the result of a common discussion.

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1. Introduction

According to tradition, the class in the university system results as being a lecture, mainly transmissive, where the instructor addresses to a more or less wide-ranging audience that generally listens with little possibility of interaction. It is standard didactics, based on the one-size-fits-all model (Barnes & Slate, 2013), without individualisation nor accounting for the informal and non-formal dimension of knowledge the students bear.

In these situations, the student is a subject that learns by reception. He assimilates the knowledge outcomes administered by the instructor and replicates them in the most analogous form to the instructor during the final evaluation.

The development of studies on constructivism, therefore on constructionism, has highlighted the importance of developing teaching ways and methodologies for higher education that are qualitative, differentiated and focused on the diagnostic analysis of the students' needs and their potentialities (Marton & Pong, 2007); to activate meaningful learning, in contrast with the mechanical learning (Ausubel, 2000) typical of transmissive models.

Such reciprocity between the teaching process and the learning process is possible in large university classes by activating situated learning procedures, where students and instructors cooperate for the co-building of knowledge. The feedback process is a cooperation and sharing tool of the objectives, enabling the dialogue between those involved in the training process and providing them with some useful information to align students and instructors and to strengthen the students' self-regulation, a necessary meta-skill not only for studying, but also for future life and work situations.

In university didactics, the students receive a feedback on the effectiveness of their learning only at the half-way or final exam; as far as the examined course is concerned, it is no longer possible to activate some restructuring strategies for the study methodologies and, if at all possible, one can generically use some information implicitly received in following exams. For the instructor, the final examination occurs too late to be of any use in addressing the learning needs that students may have had during the taught module or programme (McLoone, Villing, & O'Keeffe, 2015).

To enable the feedback in large university classes, some experiments with technological devices, such as clickers or software and autonomous answer systems, have been made. These devices have enabled immediate feedback between instructor and student, either in anonymous and normal forms, which can structure and implement learning environments that overcome the lesson space-time and build positive interactions with effective outcomes in students' learning results, motivation, and involvement, as well as in the learning design (Keough, 2012).

2. Background: feedback in higher education

The topic of feedback in university didactics has been investigated in literature for over thirty years: both the progressive, different vision of the student and the development of research against transmissive didactics have been discussed, particularly in regards to the vocational training courses based on the strengthening of expertise required by the workplace. In such a context, the investigation perspective about the feedback has changed too: "based on this idea – that the quality of the students' interaction with delivered feedback is as important as the quality of the transmitted message – researchers have begun to re-conceptualize the feedback process" (Nicol, 2018, p. 48).

Hattie and Timperley (2007) have identified "four levels of feedback: the task, the processing, the regulatory, and the self-levels. Effective feedback at the task, process, and self-regulatory levels is interrelated" (p. 102). To be effective, the feedback must be clear, propositional, meaningful and compatible with the students' previous knowledge, bearing in mind the cognitive load and the personal zone of proximal development and, most of all, it must help the student to build logical connections (Hattie & Clark, 2018).

The constructionist vision manages two types of feedback playing different roles in learning: intrinsic and extrinsic (Laurillard, 2012). The first, intrinsic feedback, is inside the action and is its direct consequence. It is supplied by the environment, by the context itself, and the student conveys it to be able to use it. The extrinsic feedback, instead, is outside the didactic action. It is supplied by a subject that tries to reduce the distance between the student and the learning objective (William, 2010).

Such types of feedback fall within a concept of single-directional feedback mainly focused on the effects that they have on knowledge building and on the student's learning process. Even when the feedback supplied by the student is considered, in addition to the feedback supplied by the instructor, it is accepted from the point of view of the benefits it implies for the student himself (Nicol, Thomson, & Breslin, 2014) and generally in terms of peer feedback (Serbati, Grion, & Tino, 2019). The most recent reflections on feedback introduce the concept of the feedback loop, meant as a triangulation between student, peer group and instructor, where there is an alternation of discussion, questions and answers, activating a cycle that involves both the students and the instructor, which is needed to adjust the actions of the latter to ensure an impact on the students' learning (Carless, 2019). Without this information, instructors are blind to the consequences of their actions and cannot, therefore, act effectively to improve the quality of learning. It is an interactionist vision of feedback (Rossi, Pentucci, Fedeli, Giannandrea, & Pennazio, 2018).

A cyclic and recursive feedback which needs the students have not only interpretative skills, but also the ability to activate an argumentative process with the instructor, an *open* and dynamic process to which the people involved are committed in mutual alignment.

The dialogic dimension of the feedback highlights its nature of being a discursive, adaptive, interactive and reflexive process (Winstone & Carless, 2019), due to which a new didactic attitude is actualised. According to Nicol (2018), the feedback has a generative value, that is, it activates in the student an inner process through which he constructs knowledge about his own ongoing activities and understanding through his own evaluative acts. Students are the definitive source of all feedback as it is, they who ultimately generate it and it is this that generates learning (Andrade, 2010).

3. The use of Student Response System in university didactics

The research focused not only on the types and goals of the feedback in higher education, but also on the ways of administering it, mainly in large size classes, where the direct exchange between the instructor and the student is complicated by the space and time bonds, making it difficult or even impossible.

The technologies have been managed as a resource to activate feedback processes and there is a wide range of literature about the use of response systems: software and integrated technology systems which give and receive some feedback.

Experimentation on the function of clickers as Personal Response System (PRS) started about 20 years ago. Different acronyms have been used to identify tools that enable interaction in class (Keough, 2012): classroom response systems (Salemi, 2009), personal response systems (Beekes, 2006), group response systems (Carnaghan & Webb, 2007), student response systems (Cunningham, 2008), electronic response systems (Hatch, Murray, & Moore, 2005), personal response units (Barnett, 2006), audience response systems (Caldwell, 2007), classroom performance systems (Petersohn, 2008), wireless course feedback systems (Rice & Bunz, 2006), classroom communication systems (Nicol & Boyle, 2003), electronic voting systems (Stuart, Brown, & Draper, 2004), and voting machines (Reay, Bao, Li, Warnakulasooriya, & Baugh, 2005). Although a wide variety of terms have been used to de-scribe clickers, the modern clicker systems available are remarkably similar (Keough, 2012). Mazur (1997) and some of his students developed the first Student Response System (SRS) to record student answers. Various companies picked up on the concept, and developed SRSs or *clickers* using either infrared or radiofrequency technology.

The first large and clunky models quickly became the size of small calculators. Their effectiveness as learning tools, but just as importantly as a means to engage students in the classroom, is documented by extensive research (Fies & Marshall, 2006).

Recent advances in classroom response systems have attempted to move beyond traditional clickers toward the use of more flexible and powerful devices, such as laptops, tablets, and smartphones. These Web-enabled devices category, stated in the literature as Web-based Student Response System (Cervato, 2019), offer the potential for easier student and faculty access and, most importantly, the possibility of a wider range of question and answer types (Shea, 2016). The most recent and used internet-based systems, also stated as cloud-based, and based on the Bring Your Own Device (BYOD) philosophy, are Mentimeter, Kahoot, Socrative, Todaysmeet, Slido, Polleverywhere, Zeetings (Compton & Allen, 2018), also available in their free version (limited) and useable to gather answers even in anonymous form: one goes out from the assessment vision of the use of the response systems to enter into the training feedback dimension. In this article all the systems are stated as SRS.

4. Method

The systematic review work has followed a series of steps according to the proposal of Machi and McEvoy (2016): select a topic (recognise and define the problem); develop tools of argumentation (create a process for solving the problem); search the literature (collect and organize the information); survey the literature (discover the evidence and build findings); critique the literature (draw a conclusion) and write the review (communicate and evaluate the conclusion).

We have chosen to focus the review on the feedback in university didactics through the SRS systems. In particular, the research aims at analysing the type of feedback that is promoted through SRS in didactic experiences led in university classrooms that welcome a wide number of students, trying to analyse the experiences led and to understand how such a feedback could affect the complex and iterative teaching and learning processes involving both instructors and students.

The following research questions have been outlined:

1. which experiences in didactics have been led to give and get some feedback and through which SRS?
2. Which type of feedback is promoted through SRS and how is it realised?
3. How does the feedback given/received through SRS influence the learning and teaching processes?

The search for literature was carried out in May-June 2019 through investigations on the databases Scopus and Web of Science, accessible from the net *Ianus* of the University of Macerata. We have chosen to define the research to articles issued in journals (including *in press* articles) published in the last three years (2017; 2018; 2019) regarding any university field. In the research done through keywords, those being different acronyms used in literature to describe the SRS, we have chosen to use the section of the acronym resulting more constant, that is, Response System, including all the answer systems, from the most traditional (clickers) to the web-based or based on social media (twitter, wiki). The first search of the database has therefore foreseen the research string Response System AND Feedback. The search was then refined to identify the contributions referred to higher education through the following Boolean operators: AND Higher Education OR University.

From this first search we had 87 articles in Scopus and 11 articles in Web of Science that were read independently by two researchers to evaluate their coherence with the main research topic and leave out those which did not refer to the didactic feedback in the university field. The result was the singling out of 28 articles in Scopus and 4 in Web of Science, which were further analysed through the support of work-sheets/tables, where, among others, the purpose of the study, the context, target, subject, type of feedback were written down, singling out the works to be considered for review, using the following inclusion and exclusion criteria.

We have included the articles mainly focused on:

- experiences or experimentations led in class (in presence and/or in blended form) with a number of students higher than 40;
- experiences considering the role of feedback both from the learning (student) point of view, as well as the teaching (instructor) point of view;
- experiences foreseeing feedback between peers.

For this work we have chosen to leave out, referring to further in-depth works, the articles focused mainly on:

- theoretical aspects or review;
- experience of didactics completely online;
- perception of the students towards the use of SRS;
- improvement of the students' performance (in particular in the final result);
- aspects, mainly technological, of the SRS.

From the comparison of the analysis of the 32 full papers we have then singled out nine articles (all indexed in Scopus) shown in Figure 1, the object of this review.

N	Authors	Title	Year	Journal	Vol	Pages
1	Papadopoulos, Natsis, Obwegeser, & Weinberger	Enriching feedback in audience response systems: Analysis and implications of objective and subjective metrics on students' performance and attitudes	2019	Journal of Computer Assisted Learning	35 (2)	305-316
2	Fang	Construction and application of internal medicine teaching interactive course based on 5-star instructional model	2019	International Journal of Emerging Technologies in Learning	14 (3)	122-138
3	González	Turning a traditional teaching setting into a feedback-rich environment	2018	International Journal of Educational Technology in Higher Education	15 (1)	1-12
4	LaDue & Shipley	Click-On-Diagram Questions: a New Tool to Study Conceptions Using Classroom Response Systems	2018	Journal of Science Education and Technology	27 (6)	492-507
5	Hubbard & Couch	The positive effect of in-class clicker questions on later exams depends on initial student performance level but not question format	2018	Computers and Education	120	1-21
6	Liu	Social media as a student response system: New evidence on learning impact	2018	Research in Learning Technology	26	1-19
7	Pearson	Tailoring Clicker Technology to Problem-Based Learning: What's the Best Approach?	2017	Journal of Chemical Education	94 (12)	1866-1872
8	Rinaldi, Lorr, & Williams	Evaluating a technology supported interactive response system during the laboratory section of a histology course	2017	Anatomical Sciences Education	10 (4)	328-338
9	McClean & Crowe	Making room for interactivity: Using the cloud-based audience response system Nearpod to enhance engagement in lectures	2017	FEMS Microbiology Letters	364 (6)	1-7

Figure 1. List of the reviewed articles.

The contributions have been further analysed (Figure 2) in relation to some thematic elements of interest such as the university course where the experience has been carried out, the type of SRS used, the number of students involved, the duration of the experiences, the type of questions that were mainly used.

N	Subject/course	SRS	Nation	Students number	Duration	Type of questions
1	Business Development with Information Systems	SAGA (self-assessment/group awareness)	Denmark	159	6 weeks	Multiple-choice enriched with information about the peers
2	Internal medicine	Classroom Teaching Interactive Response System (CIRS) + Moodle	China	90	One semester	Multiple-choice, completion, true-false
3	Civil Engineering	ExitTicket + Blackboard	Ireland	51	One semester	Multiple-choice, true-false, numerical
4	Introductory Geology	Top Hat	USA	71	Two sessions of a university course	Click-on-diagram (COD)
5	Introductory Biology	Clickers	USA	468	Two sessions of a university course	Multiple-choice and multiple-true-false
6	Accounting	Twitter	Australia	150	One semester	Hashtag quiz
7	Chemistry	Turning Technologies radio frequency (RF) clickers + Turning Technology NXT clickers	UK	127	Two years	Multiple-choice + multiple-choice and short-answer
8	Histology	Pearson Learning Catalytic	USA	41	One semester	Composite sketch type questions
9	Pharmaceutical Analysis, Bioanalysis for Nutrition, Bioanalytical Chemistry	Nearpod	North Ireland (UK)	125	Different semesters related to the involved courses	Polls, draw it activities, multiple-choice, open-ended

Figure 2. List of the articles and thematic elements of interest.

5. Results

The selected contributions are geographically spread among Europe (4), the United States of America (3), China (1) and Australia (1). They focus mainly on scientific subjects, refer to experiences that lasted weeks/months, use different SRS, both open and proprietary. In two cases, they are integrated into platforms like Blackboard and Moodle and propose, in addition to the classic questions with multiple choice and true/false answers, also questions with a visual plant.

5.1. Which experiences have been led in didactics to give and get some feedback and through which SRS?

The selected contributions show some experiences in the use of different types of SRS in didactic activities tending to overcome the traditional transmissive model to go towards more interactive and involving lessons, often foreseeing a discussion with peers. Most of the contributions refer to a specific pedagogic-didactic approach like the 5-Star Instructional Model [2], the Gamification [3], the Peer Instruction [1, 5, 7] the TEFA (Technology Enhanced Formative Assessment) [4] and enable us to underline that it is not really the technologies themselves which bring some benefits to the teaching-learning process but what counts and makes the difference is the way such technologies are inserted in a training ecosystem, where the learning design is essential.

The essay by Fang (2019) [2] shows a study integrating the 5-Star Instructional Model with a series of CIRS answers to improve teaching and learning in an Internal Medicine course. The author introduces the 5-Star Instructional Model as a new teaching theory originally proposed by Merril (Salter, Richards, & Carey, 2004) focusing on problem solving and the consistency of the teaching process and the learning process that provides theoretical guidance for curriculum design. The teaching process includes four cycling stages: activating original knowledge, displaying and demonstrating new knowledge, trying application exercise, and integrated mastery. Such an approach is combined with the use of Classroom Teaching Interactive Response System (CIRS) realized by Stanford University, a system integrated with hand-held sensors, wireless voting devices, and smartphones as the carrier to realize teacher-student interaction and information feedback in the classroom. In this experience also the Moodle platform was integrated. The focus of the path was the course design for which a specific exemplification template is provided and detailed directions about the design steps coherent with the didactic model mentioned above that the instructor has to follow are given. The instructor must combine objectives, characteristics and students' difficulties to plan the path and the questions. The results highlight how such an approach can improve the students' performances, their interest and involvement, their ability to manage problem solving, their deep comprehension of the contents and are particularly meaningful also for the instructor that can develop clear teaching thoughts and logic, and constantly adjust and readdress the teaching process.

The essay by González (2018) [3] proposes a path that integrates games with the SRS, with the objective of motivating and involving the students, providing them prompt feedback and helping them to grasp the contents of the session in the two Civil Engineering modules. The Gamification activity *Surviving Le Tour de France* was planned to supply continuous monitoring and assessment that provide immediate feedback for teacher and students. The modules syllabus was divided into stages to simulate a bike race introduced as a rich storyline with a longitudinal development. Every 1-2 hours lesson foresaw a more traditional part of topic presentation/deepening and then a stage formed by time questions via SRS to which the students accessed through mobile/tablet and answered individually (to increase some points and get a higher position in the chart, both the correct answer and the time were calculated). The technology used was SRS ExitTicket chosen due to its graphic interface and for the possibility of measuring the answering time in addition to the percentages. The students and the instructor had the immediate result on their devices, in addition, the results were projected and shared in class for the comments. The platform Blackboard was used to visualize the global results of the race and also to see again the materials and the whole path made. The outcomes of the path have shown that the students, in addition to being more motivated, studied more and had better results in comparison to a traditional path. The author points out that such effects could be attributed to a better alignment between outcomes and assessment and to the intensity of the same evaluation the game enabled. In addition, the activity could have contributed to support and maintain the empowering sense of taking charge of their own learning in a way that a traditional teaching setting cannot meet.

Different contributions [1, 7, 5] consider in particular the role the peers have in the feedback process quoting as pedagogic reference approach the paradigm of the Peer Instruction by Mazur and colleagues (Crouch & Mazur, 2001; Mazur, 1997; 2009; Watkins & Mazur, 2010) foreseeing a structured questioning process usually organized as follows: the students answer/vote individually; feedback (the percentages of the answers) is presented to the students by the SRS; the teacher asks the students to discuss their answer with peers (only if a low percentage of answers are correct); the students revote (crucial phase as it invites the students to reflect and consider the feedback received either in automatic form by the answerer and by the peers); the students receive corrective feedback and engage in a class discussion where the instructor supplies further detailed studies (Papadopoulos et al., 2019).

The essay by Papadopoulos and colleagues (2019) [1] analyses how the questions/activities set forth through SRS can be integrated with different metacognitive information for the peers to enrich the feedback and be beneficial for the students of the Business Development with Information Systems course. The reference pedagogic approach is the Peer Instruction method suggested by Mazur that in this experience is reconsidered replacing the brief peer discussion session with enriched feedback that include, in addition to percentage of reply, the preparation metric (how prepared the students were feeling before starting the activity), the confidence metric (how confident the students were feeling after answering a question) and the past performance metric (how the students had performed in previous SRS activities). Such a reconsidering was suitably thought for large classes where the discussions among peers are not always possible and to be used in activities with SRS that are short and do not continuously interrupt the lesson's flow. The tool used is SAGA (Self-Assessment/Group Awareness) a web-based audience response system tool design and developed by the research team. In fact, it was necessary to design a system that enabled to integrate the added information coming from the metrics described above to the percentages of automatic answer.

The study highlighted in particular the beneficial effects in supplying the preparation level and the confidence level of the peers as *feedback metrics* in the SRS as such information, which is added to the traditional questions through answerers, enables not only having a more detailed image of the class, but enables the students to answer more correctly to complex questions (where the answers differ among the students), supporting them in their revision strategies, and providing a basis for modification of existing knowledge structures and schemes.

The essay by Pearson (2017) [7] shows the experience led in a Chemistry course within the *Project Ponder* project-oriented to track the pedagogical benefit of clicker technology when applied to problem-based learning. The project experimented two different approaches in the use of clickers, having as a pedagogical reference perspective the above-mentioned Peer Instruction approach. In the first year the clickers were used to establish the starting level of confidence of the students with a topic and with their needs and to enable the instructor to design the path, fine-tuning the consignment ways, making sure the students perceived the activity as beneficial and suited to their level. Then, multiple-choice questions were integrated into eight planned problem class sessions lasting 1-2 hours. The students were given a Turning Technologies Radio Frequency (RF) clicker handset capable of answering multiple-choice questions. During the second year they oriented towards a team-based clicker model organizing the students in 32 groups and supplying an advanced model of clickers called Turning Technologies NXT handsets, which consist of a large LCD screen and allow short-answer questions. Both approaches have shown improvements in examination performance and the students have signalled that their learning experience has improved in both cases and has enabled them to think more deeply in class, nevertheless, the team-based approach resulted in being the one remarkably more liked by the students.

Even the essay by Hubbard and Couch (2018) [5] proposes interactive lessons, where the students of an Introductory Biology course are engaged in clickers with peer discussion during class. Together with the focus on the Peer Instruction approach, the work also concentrates on the different formats of the questions, trying to investigate if the different format multiple-true-false or multiple-choice affected the final performance, even in relation to the high and low performing students and how the peers' answer influences the answer of the single student.

Following the peer instruction sequence presented above, the students have first answered individually to the 76 questions in both formats and then they have discussed such questions in group (there were 61 and 49 groups in the two sessions).

The traditional 5-button clickers were used as technology. Notwithstanding this, the researchers had supposed that the multiple-true-false question format could positively encourage the students to discuss the different options more deeply and by doing that, enabled a meaningful impact in the conceptual understanding and, in the final exam, in comparison to multiple-choice questions, no differences were found in the final performances of the students that had answered the two formats. However, we have to consider that both formats of the questions foresaw a peer instruction approach that could have affected such data. The clickers had, on the whole, a positive effect on the performance of the students' exams, especially for the students with a higher performance. In addition, it was highlighted that the answers given inside the discussion groups between peers had influenced positively the students in giving the right answer and therefore in the contents comprehension.

Other contributions have proposed interactive lessons where the type of questions introduced through SRS had had an important role in the feedback process. In fact, in addition to the classic multiple-choice and true-false questions, some visual ones were used particularly suited to the fields of scientific subjects. Through the visual plan SRS potentialities, the instructor can understand in real time the students' conceptualisations, discuss them together and make an adjustment in action either addressing the teaching towards the conceptual change or the systematisation of mental models possessed by the students. In two cases [4, 8] such SRS are used to highlight and overcome the students' misconceptions and, in a case, in particular, to promote engagement and active learning [9].

The contribution by LaDue and Shipley (2018) [4] concentrates right on investigating how the click-on-diagram (COD) questions administrated using a SRS, could be a research tool for identifying and discover robust spatial misconceptions in Geology. The study refers to the Chi's (2008) framework of conceptual change to identify and modify in particular the false beliefs and robust misconceptions. Another framework is the TEFA (Technology Enhanced Formative Assessment) (Beatty & Gerace, 2009) a pedagogic approach for teaching science with classroom response technology born as extension in the *Assessing-to-Learn* and *Question-Driven Instruction* approaches at the University of Massachusetts

Physics Education Research Group and that is based on four core principles: question-driven instruction, dialogical discourse, formative assessment, and meta-level communication. The experience used Top Hat as technology, a web-based SRS enabling the instructor to download the coordinates of each student click. Through the COD questions the students respond to a spatially open-ended question, since they click directly on a diagram and enable, better than the multiple-choice questions, to single out the space concepts as providing insight about how and how much student mental model may differ from the scientific consensus. The realised activity foresaw the COD questions administering asked pre-instruction, post-instruction and at the end of the course. The students were asked in that way to commit to a prediction, by clicking on diagram, the instructor provides feedback on the spatial location of the correct answer by showing the resulting heat map generated by Top Hat and noting the correct location or regions.

The essay by Rinaldi and colleagues (2017) [8] proposes interactive workshop lessons using the composite sketch type questions to identify the misconceptions *on the go*, supply a more formal feedback, immediate and also deferred in comparison to the informal one that generally is obtained in the workshop activities and promote a more inclusive teaching atmosphere. The activity used Internet based teaching tool Pearson Learning Catalytic (offered by the company for free) as SRS, as it enabled the use of word cloud, short or long answers, identifying regions and sketching questions that, according to the authors, enables a better analysis of the misconceptions by the instructor and enables the students to ask questions in real time without having to raise their hands. Four modules with 10-15 questions were proposed, introduced as *Interactive review session* each lasting fifteen minutes/half an hour. The topics had been previously dealt with in the course of the week and had been thought of by the instructors, one day before, bearing in mind the previous misconceptions. The results, even though they did not show any difference in the grades, were positive in relation to the identification of the misconceptions, in involving marginalised students and in forming a new communication venue between students and instructors.

The study by McClean and Crowe (2017) [9] is aimed at promoting active learning and engagement through interactive and multimedia lessons in Pharmacy and Bioscience modules through the web based/app Nearpod tool. Through such a SRS it is in fact possible to propose open-ended questions and to draw activities that allow students to submit sketches of structures, representation of equipment, mathematical calculations or annotation of figure/diagram. It is also possible to sketch a graphical representation of data and then submit these to the instructor who can share examples with the class. The activity foresaw the preventive uploading of the materials (PPT, Keynote) in the web space of Nearpod, the addition of different types of interactive questions, and the administration of the lesson via internet to the students' devices, who knew they had to bring them to class and who accessed the lesson with a suitable code. At the end of the lesson the instructor could access a detailed report of all the students' interactions and materials and was able to add some notes and share the reports with the students, who could always access the materials even after the lesson.

The promotion of engagement and of the students' attention is the focus of the article by Liu (2018) [6] too, which, differently from the other experiences where the SRS systems with specific software were used, proposes a Twitter-based synchronous activities path, also aimed at giving the students an immediate and focused feedback to enable the instructor to identify either misconceptions or weaknesses in the comprehension of the material of the Accounting course. At the beginning of the course, a Twitter account and a hashtag were created, and the students were given a guide to use Twitter in the active learning activities considered fundamental by the author. Every lesson foresaw a quiz realised through Twitter and 3-4 questions were projected at strategic intervals, which the students answered through hashtags in 2-3 minutes, after which there was the projection of the right answer and further explanations by the instructor. The students could also ask further questions or insert further comments, even if such a possibility wasn't greatly used. The results highlighted the fact that students were more prone to participate in such activities if they were already familiar with the technology used and that the students' participation in active learning was promoted. The results also displayed the fact that Twitter is a platform, enabling two-way student-instructor communication and, finally, since the lessons were also video recorded, that the students found the activities on Twitter useful, independent of whether they participated live or watched the recordings of the lessons online.

5.2. Which type of feedback is promoted and how is it realised? Which effects does the feedback produce on the teaching/learning process?

The selection and the analysis of the nine essays have the goal of making feedback paths emerge in didactics that do not foresee simple one-way question-answer processes, but that have an outcome, both in the learning and in the teaching, of starting potential cyclic processes, where the dialogue between student and instructor, aimed at a greater effectiveness of teaching-learning, becomes a usual posture. Therefore, the two questions have been analysed contextually.

The immediate feedback, supplied in real time, described in the articles, can be classified in three types, according to the directionality and reciprocity between the people involved in the process and the effects, in a transformative sense, it could have on them (Figure 3).

The lower and less incisive level on the general didactic process is the feedback defined by Nicol (2010) as transmissive process: "Teachers 'transmit' feedback messages to students about what is right and wrong in their academic work, about its strengths and weaknesses, and students use this information to make subsequent improvements" (Nicol & McFarlane-Dick, 2006, p. 201).

Type	Effect on student	Effect on instructor	Articles
Transmissive	Functional Informative	Evaluative	5, 6, 7
Interactive	Corrective	Regulative	1, 4, 8, 9
Recursive	Formative	Restructurative Reflexive	2, 3

Figure 3. Analysis of the types of feedback.

Even by building a bridge between instructor and student, it is basically one-way feedback, as the instructor answers to the question asked by the student or, in the case of the use of technologies with an automatic reply, it intervenes for the most relevant mistakes in percentage.

The problems linked to this type of feedback are several, but essentially they concern just the way and the direction of the message supplied to the students: the message is complex and difficult to decode, convey and put into action by the student, it doesn't activate a sense exchange, rather it supplies either a supplement of information or its reformulation. “Feedback, as has been argued earlier, is not a monologue. The meaning of feedback comments is not transmitted from the teacher to the student; rather meaning comes into being through interaction and dialogue” (Nicol, 2010, p. 507).

The essay by Hubbard and Couch (2018) [5] offers an example in this sense. The experimentation proposes in fact the use of clickers to track the students’ performance, with closed multiple choice questions that included known misconceptions or point of confusion among the four options. The students are asked to answer for the first time individually, a second time after a discussion with the group of peers (peer feedback) and feedback by the instructor about the right and wrong answers. The instructor’s feedback is of an informative type, it quantitatively increases the students’ knowledge, but it does not seem to be metacognitive. It has instead an orientation function for the study: “Clicker questions may also alert students to important content. One study found that students actually perform better on exams when content was ‘flagged’ as important by the instructor relative to when content was targeted by clickers questions” (ivi, p. 9).

The essay by Liu (2018) [6] illustrates an experiment of communicative feedback between instructor and student supplied through Twitter, to encourage students to stay engaged and attentive during lectures by providing them with the opportunity to become active participants in the learning process and to enable students to receive immediate feedback.

“These activities can also be useful in courses with technically complex content, where timely feedback may be particularly helpful to students in solidifying their knowledge” (Liu, 2018, p. 2052), but they do not provide any acknowledgement on the metacognitive dimension: the instructor can evaluate in general terms the knowledge acquired by the students but he cannot observe either the signs of progress or the mechanisms of the knowledge structuring.

The essay by Pearson (2017) [7] finally introduces the concept of iterative feedback, as it proposes a series of questions repeated during the different weeks of a two-years course. From the instructor’s point of view, the SRS “is also mindful of instructors’ requirement for logistical ease when delivering to large student cohorts” (ivi, p. 1866).

From the examination of the experiences introduced one notices that such a type of feedback has a functional connotation for the students: it offers information to increase and strengthen their knowledge and orients the study towards a positive outcome of the final exam, while for the instructor it is evaluative, enabling him to highlight where the students’ gaps in knowledge are and to understand, throughout the didactic process, which topics to deepen for the improvement of the students’ performances.

Since, from transmissive feedback, addressed from the instructor to the student, one goes to double-way feedback that is with transformative information, both at a learning and at a teaching level, we can talk about it being interactive feedback. By interactive feedback one means a dialogic form activated between student and instructor, a “rethinking the unilateral notion of feedback from one in which information is transmitted from the teacher to the student to a bilateral and multilateral one which positions students as active learners seeking to inform their own judgements through resort to information from various others” (Boud & Molloy, 2013, p. 700).

Such a way to activate multilateral feedback processes is shown in the contribution by Papadopoulos et al. (2019) [1], who talk about feedback loop (Carless, 2019), which is a cyclic and recursive feedback with effects both on the instructor and on the student, supplying information to both to regulate, transform, and improve the teaching and learning actions.

The transformation in terms of learning is activated by the corrective component of the feedback: “whereas confirmatory feedback has been considered from a reinforcement perspective, corrective feedback is supposed to lead to cognitive elaboration and correction of mental schemes” (Papadopoulos et al., 2019, p. 307) [1].

LaDue and Shipley (2018) [4] also speak about corrective feedback and activate a feedback process foreseeing the analysis by the students of images and diagrams illustrating space and time conceptualisations belonging to geology and the selection or the positioning, within such iconic devices, according to the examined concept.

Such a procedure is considered effective to make the students’ misconceptions about some fundamental nucleus of the subject emerge and to correct them. It is a progression in comparison to simple knowledge implementation: the students are required to have “an ontological shift to a different conceptual category with different plausible attributes” (ivi, p. 492).

McClean and Crowe (2017) [9] affirm that to activate corrective interactive processes of the students’ mental and metacognitive models in comparison to the progression in the study, a review of the lecture content is required. “Contact time with students is a valuable commodity and should, therefore, be used to optimal effect, utilising active learning approaches to deliver and test key concepts” (ivi, p. 2). The authors underline the transformability of the interactive feedback on the teaching strategies: the regulation in action becomes necessary, but also a pre-design which, both on the epistemological and the methodological plans, proposes innovation issues, foreseeing an online room where the activity and the resources are put at the students’ disposal to be consulted outside the live lesson. There is the opening up of the idea of a systemic digital space, where one does not limit to the clicker the asking of a question along the didactic action, but that can extend the student-instructor interaction beyond the classroom.

Rinaldi et al. (2017) [8] again state the need to modify the teaching strategies and they propose the experiment of continuous and constructive feedback started through “an interactive cloud-based Classroom Response System (CRS) to identify misconceptions ‘on-the-go’, minimize erroneous interpretation due to contradictory or confusing informal feedback, and obtain a more inclusive teaching atmosphere” (pp. 329-330). The activity foresees the production, within a laboratory course, of reports on fundamental topics of histology, which then undergo an interactive feedback review process by the peers and the instructors. The feedback does not have an evaluative value: the instructors “utilize these to provide constructive feedback to students and gain insight into the misinterpretations and gaps in students understanding allowing modifications in teaching strategies” (ivi, p. 328). The authors notice that, at the end of the experiment, the instructors wondered about the possible ways of arranging a constructive feedback plan for the students, useful for the instructors to arrange an effective and involving learning environment.

In synthesis, it is possible to state that interactive feedback produces in the students the correction of their misconceptions and, therefore, the deep restructuring of mental processes. At the same time, in identifying such misconceptions often transparent for the instructor, it facilitates the regulation in action and activates the instructor’s reflexivity towards the arrangement of effective dialogic devices, which can really intercept the students’ training needs; it is an overcoming of the instructors’ pre-conceptions in relation to the students' thoughts on the subject in order to get to an effective analysis of cognitive conflicts and the false beliefs they have.

Is it possible to go beyond such a productive form of interactive, multidirectional and transformative feedback, both for the teaching and for the learning?

According to Fang (2019) [2] we can activate feedback with those characteristics within a training ecosystem that accounts for the students' existing experiences and previous knowledge to structure the new knowledge nucleus to be taught. "In the process of the interactive feedback, it means to apply and practice new knowledge for integrated mastery of new knowledge. On one hand, it fully reflects students' cognition and mastery of new knowledge. On the other hand, teachers and students can think, summarise, discuss the feedback results, and finally connect the learned knowledge with real life" (ivi, p. 129).

From the instructor's point of view, the transformability of such a feedback system is in the learning design process: not only do the instructors "need to organize and display the teaching content, and at the same time carry out the teaching interactive feedback design, and conduct design of learning and guiding" (Fang, 2019, p. 129), but they have to be available to do a continuous re-design, "to adjust teaching strategies and contents any time" (ivi, p. 130). The author underlines that it is about a recursive and continuous process that needs two basic assumptions: on one side, the feedback device must start from a validated and acknowledged didactic reference model, which could lead the design, the action and the reflection. In this case Fang experiments a training plan based on the 5-star Instructional Model by David Merrill (2002). On the other side, the instructors that want to activate didactic methodologies of such a kind must be trained to structure and manage an environment network where the technological devices dialogue with the pedagogic assumptions. "During the teaching process, it is necessary to adjust temporarily, adapt to changes, and control the teaching progress so as to guarantee no deviation from teaching tasks, which obviously sets high requirements for teachers' teaching attainment, and brings certain pressure for teachers. Teachers may not implement the teaching mode from beginning to end due to ability deficiency. Thus, it is necessary to strengthen training for teachers, and intensify teachers' understanding and application of 5-Star Instructional Model and smartphone CIRS" (Fang, 2019, p. 136) [2].

The alignment between student and instructor is, therefore, one of the products of this kind of feedback, which can be defined recursive and systemic, as not the simple planning of feedback activities becomes fundamental, but the outlying of a training learning ecosystem with suited feedback functionalities: an ecosystem where, differently from what happens in the ecosystem meant according to natural sciences, the adjustment of the parameters does not happen in a completely automatic way, but it requires the instructor's intentional action, who supersedes the balance of the learning system to keep a constant alignment between the progress of his didactic action and the progress of the students' learning (Bonanno, Bozzo, & Sapia, 2019).

A similar idea is promoted in the essay by Gonzàlez (2018) [3], where a rich feedback environment is described, which is a complex interaction structure between students and instructor and, in this case, creates a blended environment, which is also suitable to attenuate the isolation feeling the distance could produce in the students. In the implemented experimentation, structured in gamification form with an immediate corrective feedback, the attention is likewise focused on learning and teaching strategies. A similar perspective is described by Ranieri, Raffaghelli, and Bruni (2018), who investigate the potential of using game-based student response systems for formative assessment and focus on the effectiveness of gamification on learning process: both with regard to the objectives achieved and with regard to the effectiveness perceived by students. Gonzales also explores the dimension of teaching: agreeing with the principles of a feedback, listed by Nicol and McFarlan-Dick (2006), among the objectives we find "to provide the facilitator immediate feedback on the delivery of topics to be reinforced, redesigned or customized for those students in need" and "to serve as a teaching strategy to enhance the curriculum, to make learning fun and to engage and challenge students" (p. 22).

The vision is clearly global, and the re-design considered as essential to intercept the students' needs. The activated feedback is recursive and continuous then and, if for the instructor it is diagnostic and restructuring for the student, it has a training value, as he has the chance of changing, within the didactic process, the learning posture, and of being aware of the objectives to be reached.

A synthesis of the review focused on the types of feedback that have transformative effects both on the teaching and on the learning, we can then state the value of recursive processes, overcoming the mechanic-ism of the giving/receiving feedback process (Grion & Tino, 2018), but activating a circularity, a feedback loop tending towards the alignment between student and instructor and a continuous re-planning and co-designing of both the learning ways of the student, and of the didactic devices.

6. Conclusions

The review highlights the presence of a wide range of literature on the use of SRS in university classes, to provide meaningful feedback to the students and to promote dialogic and personalised lessons. Nevertheless, most experimentation proposes one-way feedback situations, where the question asked the student has an evaluative or a preparatory function with respect to the final exam.

The nine articles selected, however, investigate the feedback perspective in a two-way exchange: this supplies some information and therefore it is transformative, both for the students' learning and for the rebuilding and adjusting of the teaching. The interactive devices and the active didactic proposals, often supported by a clear didactic-pedagogic reference approach, are gained most of all by integrating and the hybridisation of different software and hardware to build learning technological ecosystems that magnify and complexify the space and time of traditional didactics.

The transformative value of the feedback is expressed at different levels of depth: the feedback of a transmissive type, with an informative value for the student; the feedback of an interactive type, enabling the student to amend the misconceptions and acting on the cognitive conflict of the beginning, while giving the instructor the possibility of regulating his teaching in action. Finally, the feedback of a recursive type, educating the student as it enters the learning process in a deep way and give the instructor useful information not only to adjust but also to rethink the general scaffolding of the course.

More recent studies start the investigation from the feedback loop concept, that is, the need for building continuous and iterated cycles of feedback between students and instructors and this seems to be the development track to be followed for future research: testing and implementing recursive feedback processes, integrated into the practice and in real time, to enable an alignment between the instructor's objectives and those of the student, between teaching and learning.

A further line of investigation to develop is the one concerning the feedback personalisation: how technologies can strengthen the exchange and the redefinition of topic elements of knowledge without leaving the interpretation to the following inputs supplied by the educator to the mere decoding of the learner (self-regulated learning or intrinsic feedback).

Since the feedback integrated into the process and into the didactic teaching and learning postures has to be designed, it is interesting to ask these questions: How is it possible to make the unstated and hidden processes of implicit feedback emerge? How can the design activate such an emergence? And how can they be shared with the peers, the instructor, and the class?

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