Hybrid and Formative Self and Cross Peer Review Process to Support Computational and Algorithmic Thinking

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Abstract: In the 2020s, the digital competences were part of the framework of 8 key competences of the European citizen for lifelong learning, employability, territorial mobility and social integration. Today, DICOMP2.2 remains an issue for Europe's Digital Decade for 2030. In the framework of trainings leading to Chartered engineer, this document presents a learner-centered hybrid teaching scenario to support the development of Computational and Algorithmic Thinking (CAT). It is based on a progressive formative Self and Cross Peer Review (SCPR) that revolves around digital self-assessment, a flipped classroom and a Rapid Application Development with peers. This design enables a new standard to be deployed for different audiences, allowing them to benefit from the collective expertise of peer review through self-assessment and cross-assessment in a team. It is also relevant in terms of strengthening interdisciplinary skills and professional style for chartered engineers whose professional goal is not to become computer programmers. The learning performance is questioned on the basis of quantitative and qualitative data from two groups' satisfaction surveys, with an emphasis on the satisfaction level, success to final examination and impact of the previous training path.

1 INTRODUCTION

The learning outcomes of accredited engineering courses cover first the scientific expertise in specific business fields and second, the scope of professional skills of the coach, leader and manager. The underlying competencies allow the chartered engineer to interact with stakeholders to achieve a common and shared goal in disruptive environments: personal effectiveness to cope with challenges, analysis and realization as an active observer and influence. As for the European citizen, the accelerated digitization of society has changed their use of digital technology in their professional practice and learning. CAT is a key competence for meeting the challenges of job retention, adult training and social integration (EU decision n° 2022/2481): the digital literacy.

Thus, to meet the Standards and Guidelines for the learning performance in Higher Education, the pedagogical approach involves active pedagogy and the design of formative learning activities (Raelin, 2008). Project-based learning (PBL) promotes peer involvement, social interaction and collective intelligence for a shared reflective learning in team.

The trainer-tutor plays an important role in the "*learn by doing*" process in reference to the didactic model LdL (Grzega, 2005): he/she provides tools and new concepts, guides without solving, while correcting and ensuring production and benevolent regulation in the group. Skills are recognized in a formative way through feedback and debriefing.

The pedagogical scenario discussed in the following fits into this framework and integrates the 4-step progressive Self and Cross Peer Review (SCPR) introduced in Nuninger et al. (2023). The aim is to improve group dynamics, facilitate learners' understanding of learning outcomes so that they engage in rigorous skills assessment, while improving the sustainability of their learning and CAT, and hence their employability.

1.1 Computer Literacy

The understanding of CAT learning objectives and priorities, as well as training approaches to address them can vary according to operational computing history, professional culture or epistemological viewpoints (Baron et al., 2014). A broader

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understanding of computer skills incorporates the "*power to act*" within a group, in addition to an object of knowledge (Fluckiger, 2019): first, the use of digital resources for the activity; second, the efficient digital production (assembling, programming and debugging); third, effective joint problem-solving (secure and thoughtful solutions, that might include digital simulation, networking and data literacy).

The focus is often on the programming language, but for repositories, it's all about functional design to describe data processing; i.e., the algorithm, as for example in the PIAF repository in 2020 (French acronym for Computational and Algorithmic Thinking in Basic Education). Shute et al. (2017) demystifies the diversity of views regarding CAT with a 6-faceted model that enables situational action with digital (see the overlap of skills in Figure 1):

- **Generalization**, meaning digital skill transfer and problem solving;
- **Abstraction,** covering data collection and analysis, pattern recognition and modelling, as well as simulation and performance;
- **Decomposition,** i.e., functional analysis;
- **Algorithm** as sets of ordered instructions carried out (by human or computer) to achieve the goal efficiently, either sequentially or in parallel with a view to automation.

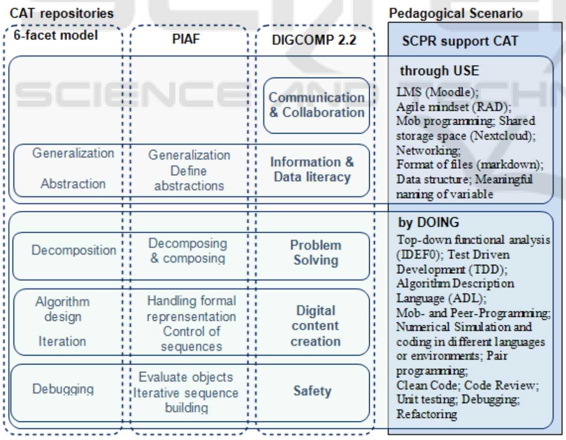

Figure 1: Overlap between CAT repositories and SCPR.

DigComp 2.2, the European Digital Competence Framework for Citizens (Vuorikari et al., 2022), explicitly highlights *data literacy* (including information), *safety* (control and performances) and introduces *communication and collaboration* (including networking). This motivates our standard pedagogical scenario presented in the following to support all CAT dimensions at levels depending on the training path. DigCompEdu for teachers, which is linked to PIAF, is essential to drive our scheme.

1.2 Evaluation and Mob Programming

In the framework of the Kolb's dynamic learning circle based on situational repetition, the operational learning performance triangle requires assessment of knowledge, understanding and the ability to do things right (apply), as well as decision-making skills and transferability (Thomas et al., 2011). Learners' involvement is initiated by the challenge and supported by the build-up of skills based on assessments (Falchikov, 2005): reinforcement of prerequisites (feed up) to initiate free self-regulated self-assessment (Andrade, 2009); teamwork (feed forward) to encourage cross-evaluation through dialogic feedback (Ajjawi & Boud, 2017); and confrontation of ideas through peer review when outside the team or in competition (Topping, 2009). The three assessment methods designed around the project are formative (Bloxham & Body, 2007). They help learners to identify their skill map for greater self-knowledge and awareness of their responsibility in achieving project team results.

In the case of RAD projects, the three evaluations are carried out operationally in the following phases:

- Pair Programming to implement computer code that has already been thought out (IDEF0), sharing the workstation display between learners (one does the input while the other controls, both self-assessing);
- Code Review for continuous improvement, sharing responsibility for the technical solution validated against specifications (unit testing);
- Mob- and peer- programming which involve progress reviews that focus on priorities, assembly and final problem-solving in an agile spirit to reach a shared consensus prior to the confrontation with competing teams.

1.3 Goals and Focus

In this paper, we enrich the standard pedagogical scenario with the Self and Cross Peer Review process (SCPR) to support "*learning by doing*" pedagogy in hybrid and blended-oriented course. It is deployed on two engineering paths involving CAT: Initial Full-Time training (IFT) and Continuous Vocational Training (CVT). Section 3 then presents the data collected and the definitions of the variables developed from the responses to the pre- and post-course satisfaction surveys. Following the results in section 4, section 5 focuses on the relevance of the proposal, highlighting obstacles and future prospects for project production support, remote interaction and supervision. Section 6 concludes the paper.

2 PEDAGOGICAL SCENARIO

Figure 2 summarizes the standard scenario based on a team-based formative project and, since 2013, the upstream ONAAG (Digital Support of Guided Self-Learning) proposed by Nuninger (2017). The device is a set of synchronized learning activities of progressive complexity implanted on the LMS Moodle: short videos with solved exercises, followed by self-assessment tests. The aim is to reinforce prerequisites, then facilitate understanding of new concepts, while developing learning autonomy, organization and digital skills. The project (50% of allocated time) focuses on results-based approaches to meeting performance expectations, and targets project management and discipline-specific problem-solving skills. The proposal, which supports CAT by inviting learners to use and act with digital technology (Figure 1), is easily adaptable to the requirements of module implementation, learning outcomes and group progression.

But in 10 years, we have observed that some students reject active pedagogy, fail to make progress with the group, have difficulty assessing themselves and others, or lack commitment. Emergency Remote Teaching during the COVID-19 crisis has reinforced the phenomenon due to limited levers for regulating groups facing priorities (work, family, then school).

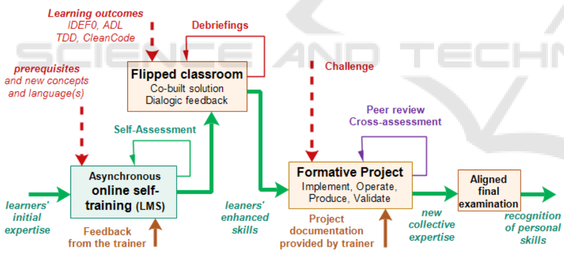

Figure 2: Standard hybrid blended-oriented course.

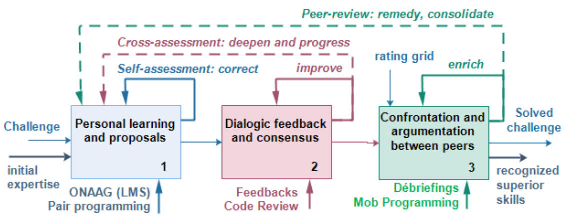

Figure 3: Self and Cross Peer Review process throughout the training project in Computer Programming TU.

To mitigate the risk of failure and assessment rejection during the project, the SCPR was formalized better in 2019 (Figure 3) in an attempt to take account of student feedback in open-ended questions:

- **Positive Points:** peer review allows you to correct yourself, changes your point of view and is interesting (argumentation, satisfaction);
- **Negative Points:** subjective opinion of peers as misunderstanding, different criteria, cronyism.

During this hero's journey (Campbell, 2008), the SCPR design encourages learner's appraisal capability (Sadler, 2010) through 3 objectives: first, **self-evaluation** to give meaning, motivate autonomy and learning (Thomas et al, 2011); second, **cross-feedback** for trust and action, then empowerment in a deeper learning act (Orsmond et al., 2000); third, **peer review** for knowledge ownership through reflexive learning based on shared, relevant, reliable and fair evaluation (Fernandez, 2015).

To support change, SCPR generates 3 kinds of outputs: **project productions** that value the work but are not sufficient to prove skills; **individual reviews on experience** to make learners aware of personal developments; and **a set of recognized skills** giving a clear picture of the level of expertise during defense with the peers before the final individual written test.

3 EXPERIMENTATION AND DATA

In the framework of a 3-year chartered engineer training, the SCPR is deployed for 2 groups (IFT and CVT) during the university years starting in 2019 and 2021, September but, 2020 is not considered due to the sanitary crisis (Table 1 and Table 2).

Table 1: Group characterization.

Groups	IFT (year 1)	CVT (year 3)
Field	Agro-industry	Production
Assessment	/ 20	Skill level
Flow 2019; 2021	47; 50	15; 10 (-33%)
Average age [min, max]	20; 20 [19,22]	36; 32 (-11%) [29, 49];[26,38]
Gender parity %	76; 89	20; 0

Table 2: Terms of the TU (hour /students, *at distance).

Teach. Unit. (Gr.)	Onaag*	Course	Project
Automation (IFT)	5h*	8h	5h
CAT (IFT)	15h*	18h	18h
Automation (CVT)	20h*	16h	16h

The target ability is always to "*understand and use problem-solving methods*", "*to define specifications in interaction with experts in the fields*" and "*to innovate while being aware of constraints, risks and technical developments*".

Up to 2019, more and more time was devoted to teamwork and personal assessment, but this was not made explicit. This leads to rejection and loss of motivation, as some learners misunderstood issue of cross-assessment. Then, the list of evaluation criteria has been improved and the progressive evaluation process has been made clearer, stressing on each step during the project (Figure 3 for the IT project). In 2021/2022, the SCPR process is fully implemented in this way. In 2019/2020, the RAD project for the large IFT group was carried out entirely online as a result of the sanitary crisis. This choice encouraged learners to code on their own, and supported pair programming through screen sharing in separate virtual classrooms. In this way, specific support from the trainer was simpler, but some students quickly accumulated difficulties, unlike others during code review. For the small CVT group, only the final step with peer-review was carried out remotely. Without direct supervision, atypical attitudes were reinforced, with less investment in training due to work pressure.

3.1 Qualitative Data

Qualitative data are collected using LMS questionnaires before the start and at the end of each TU; the former being mandatory. The aim is to raise awareness of personal expectations and characterize the group in terms of previous training path (*preferred pedagogy*, *identified assessment experience*, CAT level and digital access). The later survey targets a personal review and whether an appetite for pedagogy has arisen. Focus is put on the level of commitment, *satisfaction*, and *felt difficulties* during self-, cross- and peer-assessment. The set of questions are “yes/no”, proposed items to select, level of relevance according to a 4-point Likert scale and open-ended questions for clarification and proposals.

3.2 Quantitative Data and Variables

Quantitative data include headcount, declared age and rating (out of 20 or skill level). Added to this are a set of two-valued *descriptors* (i=1, up to 3) associated to close-ended questions from surveys at the beginning of the course (letter B in the name) and finish (F). They are used to build *scoring variables*, and corresponding *difference variables* between the learner's response before and after the course (prefix Δ). *Final scores* (prefix S in the name) and *counter-performance index* (cpi) are new indicators, modelled on the basis of available data to assess the effects of the SCPR and the impact of *learner profiles*. Subscript *n* indicates normalized variables.

3.2.1 Learning Profile Characterization

The *learning profile* is described using two dimensions (Table 3): *pedagogical preference* (pp1, pp2, pp3) and *evaluation mode experience* (ee1, ee2, ee3); each with three exclusive descriptors (yes/no) that lead to corresponding difference variables to point evolution (Table 4) with expected value due to SCPR effect (Table 5). At the end of the course, the *final feelings* about the evaluation experience are described by the *positive feelings* and the *expressed difficulty* to assess (Table 6).

Table 3: Descriptors for *pedagogical preference* pp<i> (main behaviour) and for *evaluation mode experience* ee<i> (self- and cross-assessment and peer-review: SA, CA, PR).

i	I prefer to (pp)	I already (ee)
1	listen to the lesson, then do solved exercises (passive)	made a personal assessment (SA)
2	prepare with documents, then ask in class (active)	assessed results of colleagues (PR)
3	do exercises in group, teamwork (cooperation and collaboration)	confronted and discussed proposals in a team (CA)

Table 4: Value meanings of *difference variables* for each descriptor (evolution): Δpp<i> (*preferred pedagogy*) and Δee<i> (*identified assessment experience*).

Val.	Δpp1, 2 and 3	Δee1, Δee2, Δee3
-1	no longer preferred	no longer recognized
0	remains preferred or not preferred	status quo: remains or not an identified experience
+1	now preferred	new skill identified

Table 5: Learning profile expected evolution with SCPR.

Δ	pp1	pp2	pp3	ee1	ee2	ee3
-1	YES					
+1		YES	YES	YES	YES	YES

Table 6: *Positive feeling* (Fpf); *expressed difficulty* (Fed).

i	I find (Fpf)	I find (Fed)
1	Motivating to have one's work evaluated	Difficult to evaluate oneself
2	Rewarding to assess the work of others	Difficult to evaluate others
3	peer review useful	-

3.2.2 Scoring Variables

Scores are the sum of the measures of the previous descriptors at both the beginning and/or finish of the course. Given the limits imposed by the number of descriptors ([3,6] for 3 and [2,4] for 2), the scores are normalized min-max on the interval [1,2] (Table 7).

Table 7: normalized scoring variables.

Score	SFd_n	SFp_n, SB/Fee_n, SB/Fpp_n
Descriptor	2	3
Input value	2, 3 or 4	3, 4, 5 or 6
Final value (possible configurations)	1 (1) 1.5 (2) 2 (1)	1 (1) 1.33 (3); 1.67 (3) 2 (1)

3.2.3 Counter-Performance Index (cpi)

The *counter-performance index* (cpi) is defined by the ratio of the normalized scores of final *expressed difficulty* ($SFed_n$) to final *positive feelings* ($SFpf_n$) that varies in [0.5; 2]. The *cpi* higher values (2; 1.5; 1.2; 1.125) underline the *difficulty felt* rather than the *positive effect*, and vice versa for lower values (0.5; 0.6; 0.75; 0.9). Note that the *cpi* only compares the two scores, without judging the reasons leading to the feelings. For example, an expressed difficulty does not necessarily mean a non-positive experience, as both can be experienced in the same way (cpi=1 represents an equilibrium between the two scores whatever their values: 1 or 2).

Class histograms of the *counter-performance index* (cpi) are drawn to assess the normality of the distributions from the cumulative frequency curve. Taking into account the number in the groups of respondents to be compared (8 and 29) and the permitted values of the index, 6 classes are set, centred on class 3 (no difference) as shown in Table 8 with the meaning of cpi values. Class widths are based on the nested mean method, with a mean of 0.25 for values ranging from 0.075 to 0.5. Our choices are consistent with the following formula and CNOMO E41.32.110N standard.

Table 8: meaning of chosen cpi classes (width, values).

cpi class	width	values (configurations)
1: more positive	0.250	0.5 (1); 0.6 (1); 0.75 (2)
e felt positive	0.175	0.9 (2)
3: balance	0.075	1 (2), i.e., no difference
4: felt difficult	0.175	0.125 (1)
5: more difficult	0.325	1.2 (1) ; 1.5 (2)
6: much more	0.5	2 (1)

3.2.4 Regression Study and Modelling

The aim is to assess whether the SCPR is beneficial overall. The study is limited to the least-squares estimation of variables cpi, $SFed_n$ and $SFpf_n$. Each model is computed with Scilab on the basis of p selected inputs from the available variables from n respondents. The squared linear correlation coefficient helps the pre-selection of variables. For redundant variables by construction, favor is given to the ones which contain information on before/after the course, or differences afterwards. Then, the candidate models are differentiated by the minimal criterion (sums of residuals divided) divided by (n-p).

4 RESULTS

Despite the low figures (Table 9), which reduce the scope of our conclusions, results presented in this section attempt to highlight the main positive aspects and limitations of the pedagogical proposal.

From 2019 to 2022, the *positive feelings* about SCPR increase by +6% and +13% respectively for at least 2 positive criteria among *motivating*, *rewarding* and *useful*. Negative or neutral opinions remain lower than 24% each year. *Expressed difficulty* rises by +41% (IFT) and +25% (CVT) of at least one criterion selected upon 2 mostly related to *self-assessment,* putting the focus on personal commitment.

Table 9: respondents to surveys (number in groups).

Period	IFT (n)	CVT (n)
2019/2020	47% (23)	80% (12)
2021/2022	58% (29)	80% (8)

4.1 Influence of Previous Training Path

Table 10 shows that previous *assessment experience* is not so different from one group to another. However, the SCPR increases the *felt difficulty* in evaluating oneself or others in the youngest age group (IFT). The opposite is true for CVT who are employees used to career reviews. SCPR stresses complexity and ethical responsibility.

Table 10: response rates for: *previous experience* at the beginning and *expressed difficulty* after the course.

Group/Year	IFT/19	IFT/21	CVT/19	CVT/21
Self-ass.	89%	46%	75%	80%
Difficulty	78%	86%	83%	63%
Peer review	58%	40%	63%	55%
Difficulty	48%	79%	58%	25%

Considering *pedagogical preference* descriptors at the start of the course (all year), an average of 90.5% (IFT) and 72.5% (CVT) of learners prefer classic teaching approaches (Bpp1). CVT group seems more inclined to follow an active pedagogy adapted to sandwich courses (average 27.5% for Bpp2). SCPR tends to enhance the preference for teamwork and flipped-classroom (Figure 4).

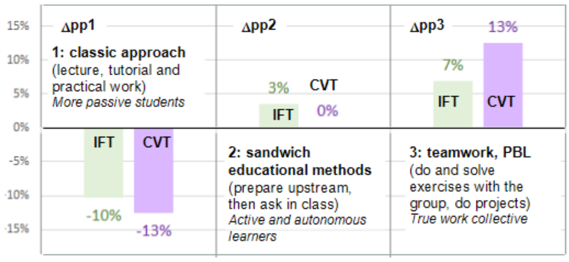

Figure 4: evolution of the *pedagogical preference* (Δpp) in 2021 (with SCPR) for IFT and CVT (29 and 8 respondents).

4.2 Qualitative Feedback on SCPR

In 2019, the most common feedback reflects a lack of confidence (in one's expertise or in the team) or refers to individual behaviours: *"fear of others' judgment"*, *"difficulty in expressing oneself contradictorily to the majority"* and *"lack of commitment or objectivity"*.

More positive learners stress the group dynamic and cohesion: "*Good atmosphere", "It helps each other" and "It federates us"*. Others reject pedagogy: "*Evaluation should be the teacher's responsibility"*, *"I get nothing out of other people's assessments (not legitimate, I don't feel competent)"*.

In 2021, CVT show more hindsight on SCPR experience and stress collective intelligence: "*We judge the whole, not just project performance.", "My work was recognized. I appreciated their critical eye for moving things forward", "goodwill is important", "Cohesion, mutual support help cope with delays."*

In 2022, more than 80% of students found the improved evaluation grid useful (33% in 2021) but a few expect more time to decipher the criteria. Others regret that the formative evaluation is not included in the final summative mark, due to school regulations.

Between 2019 and 2021, the pedagogical proposal tends to lead to a more homogeneous level for IFT group during the first semester (normal distribution centered on 10, but with a decrease of one point in standard deviation, minimum mark rising by 3 points). Changes in the TU organization (2nd semester) forbid grade comparisons, but SCPR seems to strongly discriminate between extreme skill levels, with the majority of the group centered on the mean. Expertise in the CVT group grows slightly and is tighter, with learners evolving faster and leading the others. The rate of remediation in the 2nd semester has fallen to 0% in 2022 (33% in 2020).

4.3 Counter-Performance Index

SCPR is clearly beneficial for CVT learners (cpi≤1: 88%) with asymmetric histogram for this small group, reducing the feeling of difficulty (Table 11). This does not seem the case for IFT (cpi>1: 59%) with non-normal distribution (50% of respondents).

Table 11: counter-performance index ΔSee_n and positioning rate in 2021 by groups IFT and CVT.

Classes (cpi value)	IFT: 29, 50%	CVT: 8, 80%
beneficial:1, 2 (<1)	24%	75%
balance:3 (=1)	17%	13%
difficult:4, 5, 6 (>1)	59%	13%
mean (std)	1.32 (0.47)	0.83 (0.32)

4.4 Impact on Assessment Experience

The vast majority of IFT students (79%) feel more experienced in assessment mode after SCPR (Figure 5), while 21% express the contrary. Comparing the descriptors evolution, +10% of learners are now aware of "*personal assessment*" (Fpp1) and +38% have carried out "*an assessment of the others*" (Fpp2). But, -21% did not "*discuss in their team*" (Fpp3). This is different for the small CVT group (non-normal distribution): +13% had exchanged with colleagues.

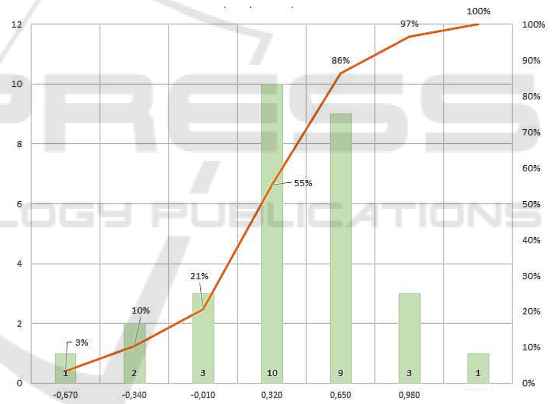

Figure 5: ΔSee_n histogram and cumulative frequencies for IFT groups ([-1,1], width 0.332, 29 respondents).

4.5 Modelling SCPR Indicators

Our recursive identification process enables us to select the relevant inputs of SCPR indicators (Table 12 and Table 13): cpi, $SFpf_n$ and $SFed_n$. Model coefficients are of the same order of magnitude in absolute value. For the CVT group, a maximum of 2 variables are sufficient for modelling, whereas up to 5 are required for IFT group. For this group, the *positive effect* of the experience (M_{SFpfn}) mostly depends on the previous training path in terms of assessment ($SBee_n$). The SCPR *negative impact* is shown by $SFee_n$ playing a role in models M_{SFedn} and

M_{cpi}. But this later model also shows the impact of the previous self-assessment experience (Bee1).

Table 12: Kept influencing inputs for the final selected models M for cpi, normalized $SFpf_n$ and $SFed_n$ (CVT).

CVT	M_{cpi}	M_{SFpf_n}	M_{SFed_n}
inputs	Bee1, $SFee_n$	$SBee_n$	$SFee_n$
(p): J_{np}	(3): 0.0306	(2): 0.0600	(3): 0.0625
$R_{cpi,y}^2$	<0.407	0.595	<0.503

Table 13: Kept influencing inputs for the final selected models M for cpi, normalized $SFpf_n$ and $SFed_n$ (IFT).

IFT	M_{cpi}	M_{SFpf_n}	M_{SFed_n}
input	Δpp1, Bee2	Bee1,2,3,Fee3	ΔSee_n
(p): J_{np}	(3): 0.206	(5): 0.102	(2): 0.0709
$R_{cpi,y}^2$	<0.113	<0.147	<0.274

5 DISCUSSION

The assessment grid provides a better understanding of learning outcomes, enables personal progress to be measured and makes it easier for learners to accept the final mark. The trainer-tutor plays a major part in team building. SCPR also requires duration of assessment phases properly defined and groups of sufficient size to allow for diversity and balance of roles, which will help internal regulation with regard to individual strategies. This point is confirmed by the CVT group in 2023/2024 with half workforce. However, in-depth analysis is limited (no reliable data on previous training paths; compliance with the European General Data Protection Regulation).

5.1 SCPR Indicators and Challenge

SCPR makes evolve the *learning profile* (Figure 6). First, SCPR enhances the *difficulty expressed to assess* ($SFed_n$) because it makes learners more aware that assessing oneself and others is an issue in itself (commitment and skills), in addition to the learning outcomes. Second, SCPR modifies the learners' *positive feeling* ($SFpf_n$) but in a way that also depends on their previous training experiences. Students at the extremes of the graph raise two questions: first, does the focus on evaluation makes the task complex, worrying and demanding ($SFed_n$>>$SFpf_n$) and therefore decreases the satisfaction level? Second, does the apparent satisfaction reflects a mastery of evaluation generated by the SCPR ($SFpf_n$>>$SFed_n$), or an insufficient commitment to quality and ethical evaluation ($SFed_n$ below $SFpf_n$), thus giving a false impression of learning performance?

In all cases, cpi seems a relevant indicator of a positive or neutral SCPR effect (cpi ≤ 1), otherwise $SFed_n$ reflects the impact of previous experiences:

- cpi>1: a high *expressed difficulty* does not prevent a positive experience (area 1 and 2);
- cpi<1: a higher *positive feeling* is favoured by a lesser sense of difficulty (area 4);
- students fully committed to the system have high levels of both indicators (area 3)

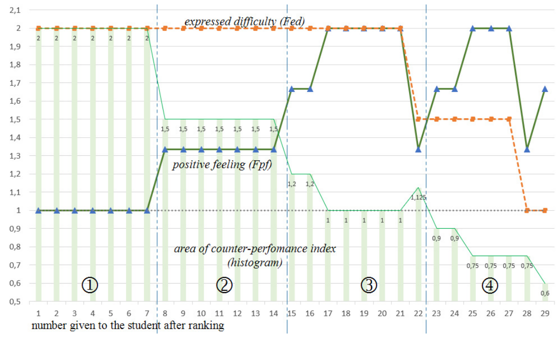

Figure 6: Sorted student ($SFed_n$, $SFpf_n$) by decreasing cpi.

5.2 SCPR Future Prospects

The influence of the trainer is not explored, nor is the assessment anonymity envisioned: engineers give their opinion on factual results, provided during teamwork and validated by benevolent, contradictory exchanges between professionals. SPRC develops the professional style and questions the engineer's ethics and societal obligations. The SCPR challenge is to compensate for the heterogeneity of learners' profiles and backgrounds within the TU available time, while reducing self-training time and despite the external constraints and personal priorities. An enriched survey at the start could help reducing the risk associated with autonomous team building; promote group dynamic and learning performance with more balanced teams based on the 9 roles defined by Belbin (*imperfect* individuals can constitute *perfect* teams).

The SCPR relevance is reflected in its evolution over several years, aiming at a more open learning environment (Jézégou, 2008) that evolves according to progression and expectations (objectives and articulation). Digitalization would facilitate team organization and production, as well as assessments recording. By visualizing relevant indicators, dashboards would support contradictory exchanges between peers with greater affordance for action and traceability through shared tools. It will support the professional development in reference to Laferrière 6-step model (Breuleux et al., 2002): a vision that motivates the change and use of new means at disposal; partnerships in a knowledge community for the tasks; leadership; connectivity and digital access; and professional curriculum including assessment.

6 CONCLUSION

The SCPR proposal is the standard of a progressive and formative evaluation process coupled with formative teamwork to enhance reflexive learning. By giving learners the opportunity to self-assess and cross-assess, the SCPR reinforces the appropriation of knowledge, self-confidence and the transfer of expertise within the group during peer review. Three relevant indicators are presented to evaluate SCPR: the *counter-performance index* (cpi); the final scores for *expressed difficulty* and *positive feeling*. Overall satisfaction is strongly influenced by previous training. This study does not identify or explain the reason for success, which may lie in supervision and social intelligence in self-regulated bigger groups.

The question of the effectiveness of the SCPR is fourfold: first, the experimentation with larger groups; second, data collection to assess the impact of previous training paths in terms of learning maturity and social intelligence (group dynamics); third, supervision dashboard to quickly detect learning trajectories that deviate from the group's evolution for better specific guidance; finally, the sustainability of the skill level achieved after the course.

Future prospects call for the digitalization of the SCPR and the search for partnerships for experiments providing more data to qualify the device on the basis of learning performance. The quality of the formative assessment and the SCPR robustness with respect to randomly constituted groups is the final issue for the full integration into academic grading, but also biases linked to the professional styles of the trainers.

REFERENCES

Ajjawi, R. & Boud, D. (2017). Researching feedback dialogue: an interactional analysis approach. Assessment and Evaluation in Higher Education, 42(2), 252–265. doi:10.1080/02602938.2015.1102863

Andrade, H. (2019). A Critical Review of Research on Student Self-Assessment. *Frontiers in Education 4.* doi:10.3389/feduc.2019.00087.

Baron, G.-L., Drot-Delange, B., Grandbastien, M., & Tort, F. (2014). Computer science education in French secondary schools: Historical and didactical perspectives, *ACM.* 14, 2(11), doi:10.1145/2602486

Bloxham, S., & Boyd, P. (2007). Developing effective assessment in higher education: A practical guide. Maidenhead, UK: Open University Press.

Breuleux, A., Laferrière, T., & Lamon, M. (2002). Capacity building within and across countries into the effective uses of ICTs. In Pan-Canadian Ed. Research Agenda Symposium «Information Technology and Learning.

Campbell, J. (2008). *The hero with a thousand faces.* (3rd ed.). New World Library.

Falchikov, N. (2005). Improving Assessment through Student's Involvement: Practical Solutions for Aiding Learning in Higher and Further Education. Routledge.

Fernandez, N. (2015). Évaluation et motivation, un couple gagnant pour soutenir l'apprentissage. In J. Leroux (dir), *Évaluer les compétences au collégial et à l'université : un guide pratique* (pp. 479-500). Montréal, QC

Fluckiger, C. (2019). Une approche didactique de l'informatique scolaire. PU de Rennes.

Grzega, J. (2005). Learning By Teaching: The Didactic Model LdL in University Classes.

Jézégou, A. (2008). Apprentissage autodirigé et formation à distance. Distances et savoirs, 6, 343-364. doi :10.3166/ds.6.343-364

Nuninger, W. (2017). Integrated Learning Environment for blended oriented course: 3-year feedback on a skill-oriented hybrid strategy. HCI Int, 9-14 July. In: Zaphiris P., Ioannou A. (Ed.) *LCT,* 10295, Springer, Cham. doi: 10.1007/978-3-319-58509-3_13

Nuninger, W., Hoogstoel, F., & Lancieri, L. (2023). A Progressive Peer Review to Enhance Formative Learning: An Issue of Trust and Motivation for Commitment. In J. Sánchez-Santamaría (Ed.), *Formative and Shared Assessment to Promote Global University Learning* (pp. 1-37). IGI Global. doi:10.4018/978-1-6684-3537-3.ch001

Orsmond, P., Merry, S. et Reiling, K. (2000). The use of student derived marking criteria in peer and self-assessment. *Assessment & Evaluation in High. Educ.*, *25*(1), 23-38. doi: 10.1080/02602930050025006

PIAF Consortium (2021). CAT in Basic Education, https://piaf.loria.fr/en/outcomes/

Sadler, D. R. (2010) Beyond feedback: developing student capability in complex appraisal, Assessment & Evaluation in Higher Education, 35:5, 535-550, doi: 10.1080/02602930903541015

Shute, V. J., Sun, Ch. & Asbell-Clarke, J. (2017). Demystifying computational thinking, in Educational Research Review, 22, Elsevier (pp. 142-158), doi: 10.1016/j.edurev.2017.09.003

Raelin, J. A. (2008). Work-based Learning. Bridging Knowledge and Action in the Workplace. (New and revised edition). San Francisco, CA: Jossey-Bass.

Thomas, G., Martin, D. & Pleasants, K. (2011). Using self- and peer-assessment to enhance students' future-learning in higher education. Journal of University Teaching & Learning Practice, 8(1), 1-17.

Topping, K. (2009). Peer Assessment. Theory into Practice, 48(1), 20–27. doi:10.1080/00405840802577569

Vuorikari, R., Kluzer, S. & Punie, Y. (2022), DigComp 2.2: EUR 31006 EN, doi:10.2760/490274, JRC128415.