DEVICES TO COUNTER THE LACK OF PRACTICE IN MATHEMATICS IN A FISRST YEAR ARCHITECTURE PROGRAMME

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ABSTRACT

The present study focuses on the whys and wherefores of the online-oriented pedagogical redesign of a course in mathematics in the context of the Feedback First-Year Project (FFYP) implemented in an architecture programme at the University of Liège (Belgium). Lead in order to support the experience and learning of freshmen within the institution, FFYP aimed to involve a group of professors from the same Faculty in a reflection about their current teaching and assessment practice and possible improvements. The teachers were especially acquainted with feedback-related issues through structured moments of personal coaching and collegial meetings, fed by the provision of theoretical resources, among which Nicol's "12 Principles of good formative assessment and feedback" (2009). This paper reports and analyses four significant devices set up in mathematics by one of the teachers in collaboration with the FFYP team; an online prerequisite test implemented on our academic online platform, a true/false quiz intermediate test, a peer-grading mock exam and an online graphic syllabus. According to Nicol's recommendations, each of these features is completed with specific feedbacks to the students. At the end of the process, students were asked about their perceptions about the implemented devices. The paper concludes with a discussion of several facilitating and challenging factors.

INTRODUCTION

Whereas some predictors of student's success directly depend on themselves (e.g. in-depth study instead of superficial study; work and study on a regular basis), quality teaching and pedagogic support play a major role in dropout prevention

(Béchard & Bédard, 2009). According to Lizio's model (Lizio, Wilson, & Simons, 2002), quality teaching is positively and significantly correlated with current level of academic achievement (r = .31), reported satisfaction with course (r = .54) and self-reported development of generic skills (r = .32).

An important part of teaching lies within the assessment of learning. Whereas assessment has long been considered as a mere operation occurring at the end of a complete learning process (Wiliam, 2011), a growing community of researcher focuses on the *why* and the *how* of the evaluative process. Assessment *of* learning therefore becomes assessment *for* learning, with evaluation as a means to promote learning, through formative assessment and feedback practices. High quality feedback practices are therefore essential. According to Nicol (2009), in order for a feedback to be of quality, 12 principles should be followed. The 12 principles aim at enhancing students' engagement in the academic life and, more importantly, students' self-regulation. For instance, the first principle urges the teachers to clarify what a good performance is, to let students clearly know and understand what is expected from them. Another principle invites teacher to encourage their student in spending great deal of time and effort in challenging task, to favour regular work.

In order to improve teaching and feedback practices within the University, a project has been developed in partnership with the Institute of Training and Research in Higher Education (IFRES), the Centre of Higher Education Didactic (CDS) and the Student Guidance Service (SGE), and implemented in five faculties. This ambitious project is entitled "Feedback First-Year Project".

FEEDBACK FIRST YEAR PROJECT

The Feedback First-Year Project (FFYP) is an action research project oriented towards First-Year students' learning support. It aims at engaging First-Year teachers in a reflection on concrete ways to develop or optimise opportunities of formative feedbacks for freshmen in order to both improve students' academic and social experience, and enhance their ability to self-regulate their learning. The teachers are assisted in their pedagogical reflection by a pluri-disciplinary team of two advisors working within the faculty premises, one psycho-pedagogical advisor and one architect

Following its implementation in three faculties (Law and Criminology; Applied Sciences; and Sciences), the FFYP was put into practice within the Faculty of Architecture. Amongst all the initiatives introduced within the faculty, the present paper focuses on the Math course's pedagogical redesign.

FFYP AND MATHEMATICS COURSE

The pedagogical redesign focuses on both didactic and pedagogical reflections in teaching mathematics in architecture programme in order to support the experience and learning of first year students. The reflective process leading to the chosen redesign formula was performed in the FFYP in three steps. With the collaboration of a student completing a Master in Didactics of Mathematics at the University of Liège, who was in charge of supporting freshmen facing problems in learning these course contents, we first managed to investigate and collect what appeared to be the main mathematical difficulties encountered by Architecture students in all the other courses taught in first year. Thanks to this inventory - which included many basic prerequisites in the first place - a list of examples was sorted according to mathematics' skills and demonstrated the lack of transfer between the disciplines.

After having analysed and cross-checked this list of purely disciplinary difficulties with her own systematic observations of the students' behaviours during the term, the professor in charge of the course worked with the FFYP team, trying to derive the more generic corresponding needs of freshmen in this course, thus determining the priority objectives of its pedagogical redesign:

- making students aware of their levels of knowledge in the mathematic prerequisites necessary for the course;
- clarifying the levels of performance required to pass the course;
- regulating the actual workload spread over the semester and supporting the engagement of students toward the course on a regular basis;
- giving students multiple and formal opportunities to confront themselves to the evaluation criteria and self-regulate throughout the semester.

Aligned with those objectives, the pedagogical redesign of the course was carefully achieved in accordance with the theoretical foundations of the FFYP. It has been made up of four different yet complementary devices which, taken separately, notably match with various "practical recommendations for improving assessment and feedback in the first year of higher education" set by Nicol (2009). Moreover, as discussed later on in our paper in the light of the formative feedback/assessment and AfL theories applied to the First-Year context, this pedagogical redesign offers the inspiring example of an integrated framework which, taken as a whole, also appears likely to support the engagement, self-regulation and learning of freshmen.
Developed in order to investigate how those four devices were perceived by the students and to support the teacher in her decision to replicate the initiative or not, a questionnaire was submitted to the public concerned.

These four significant devices set up in mathematics consist in: an online prerequisite test implemented on our academic online platform, a true/false quiz intermediate test, a peer-grading mock exam and an online graphic syllabus. They are described in the following section.

FOUR DEVICES IMPLEMENTED IN MATHEMATICS

The four devices were added to complete the course framework, the weekly twohour exercises session directly following the theoretical transmission of knowledge. During these practise sessions given in auditorium, the teacher receives the assistance of 4 math master students.

The online prerequisite test (PT)

Based on years of math teaching in an architecture programme and on the observed recurring lack of basic mathematical skills knowledge amongst students, several categories of essential math prerequisites have been established:

- Knowing how to calculate numbers
- Knowing how to measure sizes
- Knowing how to structure space
- Knowing how to build logical links/associations.
- Knowing how to use scales. We specifically added this last category because of the importance of scales' understanding in architecture.

Following the creation of this list, we developed an online prerequisite test on the academic online platform (see figure 1).

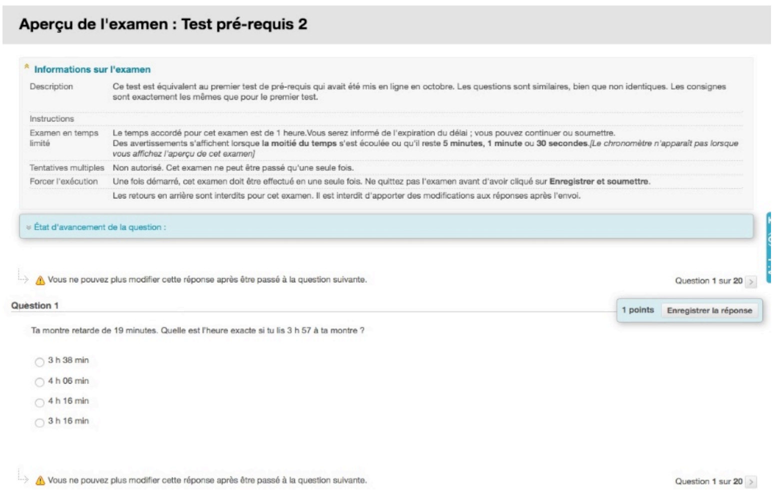

Figure 1 Prerequisite test

This test consists in 20 questions from all five aforementioned categories. Each wrong entered answer was followed by a specific feedback inviting students to revise the category of prerequisite associated with the question (e.g. when students enters a wrong answer on a question about how to calculate numbers, the automatic feedback invites them to revise the rules of number calculation). The introduction of specific feedback is in direct line with Nicol's third recommendation encouraging teacher to give high quality feedback to help students to self-correct (2009). Students could complete the test as many times as they wish during a limited period of time. Since the mastery of prerequisites are essential to follow and understand the actual math course, the test was available online only during the first six weeks of teaching. Although the test was not mandatory, it was strongly recommended to complete it and to score 15/20 and higher as to ascertain a good knowledge of the prerequisites.

A good proportion of students decided to complete the prerequisite test (57% of the total cohort).

A total of 128 questions provided by the teacher has been entered on the online platform, allowing the teacher to create as many 20-questions test as she wishes.

The true/false quizzes – Intermediate test (IT)

In order to integrate formative assessment within the math course as well as encourage students to engage time and effort in more regular work (cf. Nicol's second principle, 2009), an intermediate test, half-way through the semester, was organised. This intermediate evaluation was also an opportunity for the students to be familiarised with assessment in a university setting, without risking their final grade. All too often, students' first confrontation with university evaluation is during their first exam. Therefore, adding to the already important anxiety of performing well at a task, this first confrontation can also be an extra source of stress.

To create the test, we use the help of a unit specialised in educational evaluation, called the SMART (Système Méthodologique d'Aide à la Réalisation de Tests).

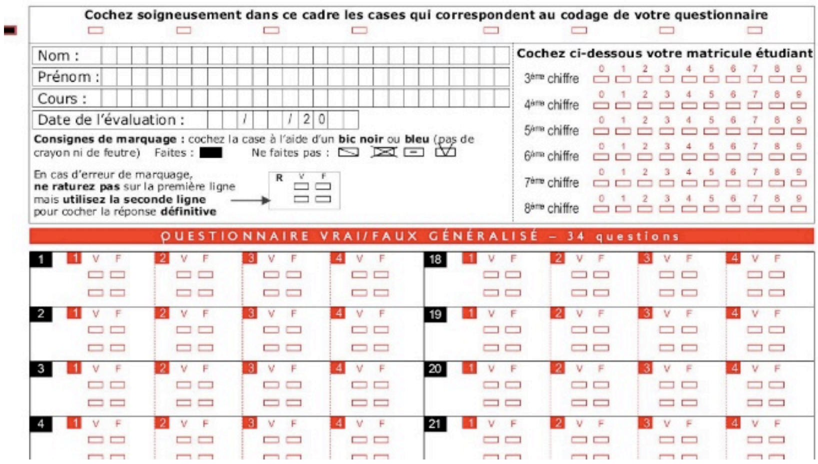
Cochez soigneusement dans ce cadre les cases qui correspondent au codage de votre questionnaire
Nom :
Prénom :
Cours :
Date de l'évaluation : / / 20
Consignes de marquage : cochez la case à l'aide d'un **bic noir** ou **bleu** (pas de crayon ni de feutre) Faites : Ne faites pas :
En cas d'erreur de marquage, **ne raturez pas** sur la première ligne mais **utilisez la seconde ligne** pour cocher la réponse **définitive**
R V F
Cochez ci-dessous votre matricule étudiant
3ème chiffre 0 1 2 3 4 5 6 7 8 9
4ème chiffre 0 1 2 3 4 5 6 7 8 9
5ème chiffre 0 1 2 3 4 5 6 7 8 9
6ème chiffre 0 1 2 3 4 5 6 7 8 9
7ème chiffre 0 1 2 3 4 5 6 7 8 9
8ème chiffre 0 1 2 3 4 5 6 7 8 9
QUESTIONNAIRE VRAI/FAUX GÉNÉRALISÉ – 34 questions
1 1 V F 2 V F 3 V F 4 V F 18 1 V F 2 V F 3 V F 4 V F
2 1 V F 2 V F 3 V F 4 V F 19 1 V F 2 V F 3 V F 4 V F
3 1 V F 2 V F 3 V F 4 V F 20 1 V F 2 V F 3 V F 4 V F
4 1 V F 2 V F 3 V F 4 V F 21 1 V F 2 V F 3 V F 4 V F

Figure 2 True/false quiz sheet

The SMART helped with the creation of high methodological quality questions and helped decide which sort of answer students would be asked to give (e.g. Multiple-choice questions, true/false quizzes, etc.). A true/false quiz questionnaire has been chosen (see figure 2). During the intermediate test, students received 15 questions.

For each question, 4 possible answers were presented. For each possible answer, students had to indicate whether it was true or false, and then report their answer on the special sheet. As for the prerequisite test, the intermediate test was not mandatory but every student whose score was of 12/20 and higher received a 2-points bonus at their January exam.
The students' attendance for the test was quite good (73% of the total student cohort) and the mean score was equally good (12.5/20).
Students receive feedbacks during the following lecture. Beside their grades, the teacher gives correct answers and warnings on the common mistakes to them.

The peer-grading mock exam

Following a similar desire to offer students with the possibility to be exposed to exam's conditions without risking their grade, and therefore deal with its potential anxiety before the exam takes place, we implemented a mock exam. We decided to use the last lecture of the year to organise it. The conditions in which the exam was organised were totally similar to the real exam's conditions. Students were asked to complete last year exam and they had two hours to do so. Using last year exam allowed us to display last year students' good (and less good) answers during the collective correction of the exam which directly followed the mock exam in the same auditorium. By doing so, students had the possibility to be confronted by an example of what is considered by the teacher as being a good performance and a less good performance, therefore clarifying what standards of performance is expected by the teacher (cf. Nicol's first principle, 2009). However, before displaying last year students' examples, students took the time to peer-grade the mock exam, with the help of the teacher who displayed the right answers on the screen and explained what was expected as an answer and why.
The students' attendance to the mock exam was lower than the one for intermediate test.

The graphic syllabus

Nicol's first principle for good quality feedback consists in the clarification of what exactly is expected from students before, during and, at the end of the year. This clarification can be achieved in many ways. One of those ways is to present the course's objectives to the students. We chose to present the course objective using a graphic syllabus, in which students can find the idea of the programme, the contents of each session as well as the links with others courses in the architecture programme (see figure 3). The graphic syllabus also contains the specific dates of each specific lesson as well as the specific dates and the locations (for presential activities) for the prerequisite test, the intermediate test and the mock exam.
At the beginning of each weekly session, a slide is displayed on the screen showing, on the left side, where the session takes place within the whole sequence of the course and, on the right side of the slide, the theoretical content of the

session and the associated exercises that will be done during the practical session (see figure 4).

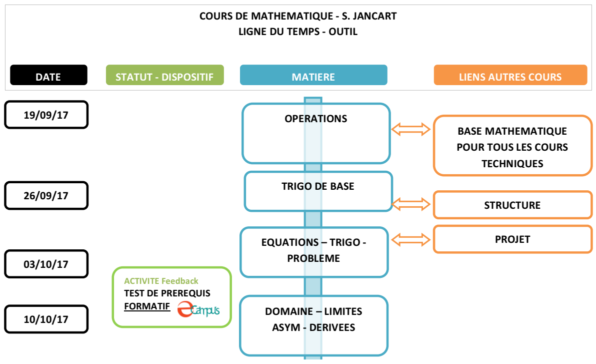

Figure 3 Graphic syllabus – links to others courses

The links and interconnections between maths and other courses (for instance trigonometry can be applied during a structure course) has been greatly appreciated by students. This interrelation between different courses of a same first-year program could results in a decompartmentalisation of the information and help students acquire a more complete and integrative understanding of their cursus. Also, if every teacher from the same year would create their own graphic syllabus and therefore share the information related to their own course, this could be of great help for the students in order to organise their work and study, according to their different deadlines within each course.

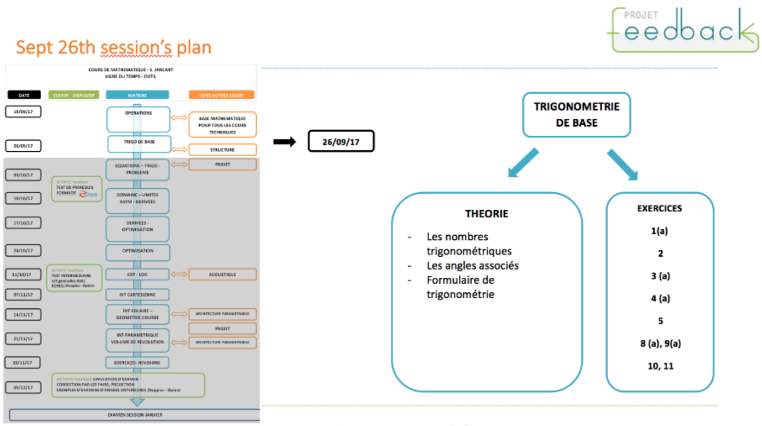

Figure 4 Graphic syllabus – week after week – Theoretical and exercises sessions

The four devices present undeniable qualities on their own, but their greatest advantage is that they work well together to improve students' engagement. In effect, based on students' participation rates, and preparation rates in a lesser extent, the integrative implementation of those devices seems to impact students' involvement in the math course.

THE PEDAGOGICAL REDESIGN AS A RELEVANT FOUR-PIECE INTEGRATED FRAMEWORK ACCORDING TO THE LITERATURE

Taken together, those four devices all worked together to improve students' experience with the math course, collectively meeting important principles of good assessment and feedback practice according to Nicol (2009) : by clarifying what is expected from them in term of courses objectives (i.e. graphic syllabus), math performance (i.e. mock exam and intermediate test) and prerequisite mastery (prerequisite test); but also by encouraging them to put time and effort in challenging learning task (intermediate test and mock exam); by providing high quality feedback to help students self-correct (prerequisite test and to some extent the intermediate test and the mock exam); and, by encouraging interaction about learning between peers and teacher (collective correction of the mock exam). All those devices were also a great source of information for the teacher who could then use it to better shape and optimise her teaching.

To this respect and as suggested above, those four devices could be seen as providing the complementary pieces of a learning-oriented jigsaw, a formative integrated environment embedding various teaching and assessment components, and thus suitable to support both the engagement and the self-regulation ability of students in this course according to the literature. Indeed, this longitudinal combination of three different opportunities of testing, strategically planned, could actually meet "the issues and challenges of helping students reframe their views and definitions of feedback in sympathy with A*f*L approaches" described by Sambell (2011, p.5), since « from this viewpoint, feedback is seen as a process which is fully integrated into the learning and teaching process, building gradually over time, with active student involvement".

For the purpose of promoting *active student involvement* in particular, this pedagogical redesign alternating those progressive and formative tests with periods of consecutive feedbacks and teaching inputs, completed by the availability of a holistic communication tool (the graphic syllabus) guiding the students through the whole process to regulate their learning, makes it compatible with the definition of this notion given by Chapuis and Stiggins (writing about *Classroom assessment for learning*) : "student involvement means that students learn to use assessment information to manage their own learning so that they understand how they learn best, know exactly where they are in relation to the defined learning targets, and plan and take the next steps in their learning " (2002, p. 41).

Beyond its relevance regarding the engagement and self-regulation of freshmen, this four-piece pedagogical redesign was also conceived with the hope to display the features of a formative environment meeting the four institutional conditions that could facilitate students' retention and success, as listed by Tinto (2010). Indeed, according to him, students are more likely to persist and graduate when they know what is expected from them, in terms of performance and effort; when the amount of support they could find in and outside the classroom and within themselves (self-efficacy) is sufficient to help them achieve the set expectations; when students receive enough opportunities of assessment and feedback about their progress; when students are fully involved in their academic life and community. Thanks to the introduction of those four consistent devices within the math course, we directly managed to improve those conditions of success for our First-Year students. By introducing a graphic syllabus, a prerequisite test, an intermediate formative test and a mock exam, we contributed to offer clearer expectations for students, to enhance the amount of classroom support and, hopefully, the student's self-efficacy, to create additional experiences of assessment and feedback, all of which in order to support freshmen integration in the university, both academically and socially.

Although the pedagogical redesign of the math course was fruitful according to the literature, it also came with a more challenging side. Rethinking the entire structure of a course takes a lot of time and effort. Because of the presence of the FFYP within the Faculty of Architecture, and therefore the presence of two educational advisors, the professor was able to put all those changes into place. In the next sections, we expose the major facilitating and challenging factors in doing so.

IDENTIFIED FACTORS THAT MADE THE IMPLEMENTATION OF THE PROJECT SUCCESSFUL

At the level of the professor in charge of the course, one of the typical FFYP traits had a direct effect on both her involvement and reflection: the guidance of a pair of advisers, consisting of a specialist in instructional sciences and a content-domain expert, who held regular meetings in order to acquaint her with feedback issues and to help her in developing, realising ideas and mastering the online platform.

The predominant factors making the project successful at the level of the targeted students were investigated through the result of a questionnaire filled out by 156 students over 255 registered, allowing for instance to derive a list of incentives to pass and prepare the tests.
The analysis of the data collected through the questionnaire revealed that 85% of the respondents reported attending to the intermediate test. Additional results also showed that students reported being highly motivated to participate in (N = 148, M = 5.79, SD = 1.9) and study (N = 148, M = 4.26, SD = 2.16) for the test because of the 2-points potential bonus. However, students reported being moderately

prepared for the test (*N* = 149, *M* = 3.34, *SD* = 1.86, on a 7-point Likert scale, from 1 *not at all* to 7 *totally*), with the main reasons for not being fully prepared being the lack of time (33%), self-assessed sufficient knowledge (23%) and architecture project (19%). Every year, architecture students have to present an architectural project that counts for a third of their final grade. The amount of time spent working on that project is therefore substantial.

In effect, when students were surveyed about their participation to the mock exam, only 50% of the respondents reported being present. The main reason for not attending was the architecture project (39%). Moreover, students reported being rather weakly prepared for the mock exam (*N* = 118, *M* = 2.61, *SD* = 1.78). Similarly to the results for the intermediate test, the lack of preparation is mainly due to the architecture project (34%) and lack of time (27%).

Despite those results, when students were asked to evaluate the usefulness of the initiatives, they reported the intermediate test (*N* = 145; *M* = 5.04, *SD* = 1.99) and the mock exam (*N* = 105; *M* = 4.3, *SD* = 1.99) as rather useful. Moreover, when surveyed about the usefulness of the prerequisite test, students reported finding the test as moderately useful (*N* = 123, *M* = 3.60, *SD* = 1.93, on a scale form 1 *not at all* to 7 *totally*).

IDENTIFIED FACTORS THAT MADE THE IMPLEMENTATION OF THE PROJECT CHALLENGING

One of the main challenges to deal with for the professor was to conceive pedagogical devices which would be compatible with the schedules of other First-Year courses and at the same time suitable for students' total workload.

Typical features of the FFYP process like the extensive use of structured moments of collective reflections about the project outputs between the programme's involved professors (plenary meetings) and the recurring suggestion made by the FFYP advisers to prepare a graphic syllabus (or a simple time-line) for each of their First-Year courses seems to be a good start to overcome this challenge.

CONCLUSION

In this paper, we presented a redesign of a mathematics course within an architecture programme. Four devices have been implemented with the aim to improve First-Year students experience with the math course. First, a graphic syllabus has been created to help student understand the sequence of the course, with information for each session as well as important dates for pedagogical activities and clear links between math course and other courses in the architecture programme. Secondly, an online prerequisite test has been developed in order to allow students to assess their own level of crucial math prerequisite mastery and to receive information helping them to fill the gap. Thirdly, an intermediate test with a 2-points bonus has been organised half-way through the semester, to give students an opportunity of formative assessment. And lastly, a mock exam took place just two weeks before the exam.

Able to capitalize on these achievements and encouraged by both the theoretical quality of the four devices (taken individually or together) and the first data collected from students, the professor is looking forward to continue and deepen this experience which hopefully will be considered as an inspiring effort for other teachers in charge of First –Year students and willing to reflect on learning environment likely to support their engagement with the help of formative feedback and A*f*L theories.

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