

# E-Learning and Affective Student's Profile in Mathematics

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**Abstract**—This paper is concerned with the personalisation of teaching/learning paths in mathematics education. Such personalisation would exploit the research results on the connection between the affective experience of the student learning mathematics and his/her success or failure in mathematics, which produces the learner's attitude towards mathematics. We present a model for the learner's affective profile in mathematics, which would extend the current user profile in an e-learning platform taking into account the learner's attitude, to be used in order to offer and manage a Unit of Learning in mathematics better tailored on the global student's needs. Tools for the implementation of the model in an e-learning platform have been devised. Activities templates suitable to various attitudes towards mathematics have been designed and their experimentation is in progress.

**Index Terms**—e-learning, user profile, mathematics education.

## I. THEORETICAL BACKGROUND

Nowadays a great confidence is placed into e-learning as the one having “*the potential to help the Union to respond to the challenge of the knowledge society, to improve the quality of the learning process, to facilitate the access to the learning resources, to address special needs...*” [11]. Currently available platforms are often used as Learning Content Management Systems, i.e. as managers of teaching resources which are labelled according to standard parameters such as kind of resource, school level, degree of deepening, size of the resource and so on. Most of the Universities offer e-reading course instead of e-learning ones.

A key challenge of e-learning is the chance of personalisation of the learning process. A relevant platform [12] makes in act such chance based on the following main features:

- the possibility to model the student storing what knowledge acquired during the learning process and retrieve, automatically, the learner's preferences concerning the typologies of contents, the didactic approach, the interaction level, the semantic density, etc.;
- the possibility for the experts to define and structure disciplinary domains, by constructing domain dictionaries, composed by a list of terms representing the relevant concepts of the disciplinary domain that we are modelling, and constructing some ontologies on such dictionaries that are modelled using graphs structure. The graph nodes are concepts (taken from

the chosen dictionary) and the arches are the relations between the concepts;

- the possibility to annotate the learning resources, by metadata, and then to link them to the concepts of the ontologies (indeed, by associating a learning object with one or more concepts, we can assume that the content of such learning object “explains” the correlated concepts).

Starting from what said above, the platform is able to create, manage and update *in itinere* a personalised Unit of Learning for each student [1].

Anyway, research on education has widely shown the complexity of teaching and learning processes, and thus the inadequacy of one-dimensional models, including the belief that the simple addition of some technology to standard teaching practices could provide considerable improvements of the outcomes.

In particular for mathematics education, any model has to consider that students' performances are affected by factors belonging to at least three different levels:

- *the cognitive level*, which involves the learning of the specific concepts and methods of the discipline, also related to the obstacles recognized by research and practice;
- *the meta-cognitive level*, which involves learners' control of their own learning processes;
- *the peri-cognitive level*<sup>1</sup>, which involves beliefs, emotions and attitudes, and all affective aspects, which are most often critical in shaping learners' decisions and performances.

In the following section we will sketch how to extend the student model in order to include somewhat from the peri-cognitive level and use it to offer a Unit of Learning in mathematics better tailored on the global student's needs.

## II. A MODEL FOR AN EXTENDED STUDENT'S PROFILE

According to the outcomes in mathematics education, in cognitive psychology and more recently in neuroscience [2,3,4,7,8,10], we define a model for the student's *affective profile* in mathematics. We have decided to take into account the attitude towards mathematics construct to build up our model:

<sup>1</sup> The term “peri-cognitive” have been introduced by the authors instead of “non-cognitive” or “affective” used by Zan in order to underline that this level involves not only affective factors but at the same time this level is not the opposite of the cognitive level.

1. the attitude construct, being defined as the consequence of the organisation of emotions and beliefs [16], contains the most of the student's "affective" information;
2. the attitude is considered the most stable affective factors among the others (emotions and beliefs) [10] and it also is a profile characteristic not linked to sporadic events.

The model takes into consideration a definition of "attitude" towards mathematics, based on the following three correlated dimensions [7]:

- the learner emotional disposal, revealed by the expression "I like/I don't like";
- the learner's view of the mathematics, reflected by his/her beliefs "The mathematics is...";
- the view which the learner has of his/her relationship with the mathematics (sense of self-efficacy), revealed by the expression, "I'm successful/I'm not successful".

The used model of attitude [7] has been validated in face-to-face learning environment. On the contrary, our learning environment foresees an automatic management of the learning process and thus it has all the related problems, such as discourses interpretation or compositions analysis. To overcome such difficulties, the model has been extended in order to better explore the interpretation that the learner gives to his/her mathematical experience, in order to better intervene in case of recovering needs.

With respect to the vision of the mathematics, the model distinguishes different levels, moving from the pure instrumental vision to the relational vision<sup>2</sup> [11], which is the one of the "mathematician", that is the view shared by the scientific community of mathematicians as positive.

With respect to the emotional disposal, the model will investigate on the feelings associated to do mathematics. This is because, as pointed out by Zan, they are sensors useful to understand the interpretation of the learner mathematics experience, as they are generated exactly by the latter, and then they are useful to choose the right didactical action.

With respect to the sense of self-efficacy, particularly meaningful are the causal attributions, that are the beliefs constructing and elaborated by a person trying to interpret his failure. They often refers to the three agent of the educational process that are the subject, the teacher, him/herself.

The choices underlying the model are schematized in the Fig. 1.

Based on the scheme described by the figure 1, we can define a tri-dimensional space, that we name mathematical affective space (Fig. 2), whose axes are the view of the mathematics, the emotional disposal, the sense of self efficiency. This mathematical tool will allows us to

<sup>2</sup> According to Skemp [11], we distinguish instrumental mathematics which is characterised by formulas, to keep in mind, exercises, products; relational mathematics, which consists in reasoning, thinking, problems, processes; which is reflected by a corresponding difference of "comprehension": instrumental understanding, which means to know rules and to be able to apply them; relational understanding, which is to be aware of connections and reasons.

monitor the profile, so that could be established if the didactical activity came to a good end.

Thus we can associate to each student a point in that space, which represents a picture of the student's affective profile in mathematics.

We use as range on the axes the values between 0 and 1, then our profile can be represented by a point within the cube with side 1. The optimal profile to be reached is clearly the vertex of the cube with coordinates (1,1,1).

We are going now to better describe the meaning of the axes and their function in the educational recovering phase.

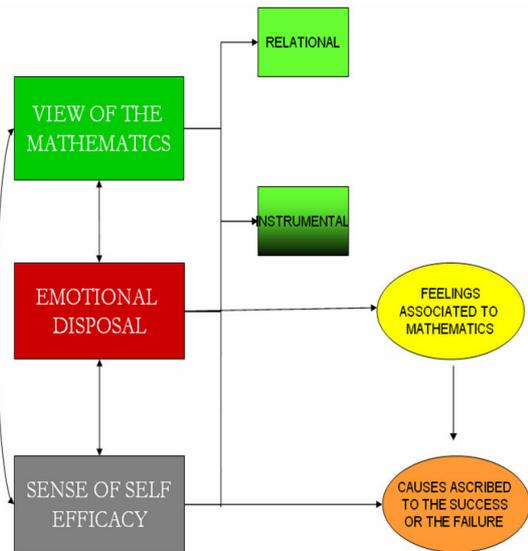


Figure 1. Scheme of the learner's affective profile in mathematics

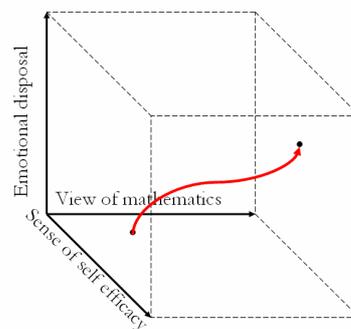


Figure 2. Mathematical affective space

A. *Axis of the view of the mathematics*

The value 1 on this axis represents the correct view of the mathematics that the learner ought to have and which corresponds to the one of the "mathematician", that is the view shared by the scientific community of mathematicians as positive, referred by Skemp as relational mathematics.

Starting from this we can distinguish three macro levels of the view of the mathematics (Fig. 3):

1. Pure instrumental level: students with this view considers mathematics as instrumental subject and at

most they will reach a comprehension of instrumental type;

2. Mixed instrumental/relational level: students with this view have a vision of instrumental type too but they are inclined to ask themselves and try to give the right reasons of the mathematical tools they use and then at most they will reach a comprehension of relational type;
3. Actual relational level: students with this view have a relational vision of the mathematics and aim to a relational comprehension as much.

*B. Axis of the sense of self-efficacy*

The value on this axis represents the student's feeling of success in mathematics. As feeling, it is different from the actual student's skills (which can be separately assessed by cognitive tests). The value 1 on this axis represents a pupil who feel himself/herself successful in mathematics.

According to the scale used, the student can have the choice to assign a value to his sense of self-efficacy (e.g. from 0 to 10). Such value, suitably normalized in the interval [0,1], gives the corresponding value on the axis. The possibility of observing change and having data sensible for monitoring is better as much the grain is fine. In the following we describe the three subintervals characterising our axis:

- [0, 0.5] : low sense of self-efficacy;
- ]0.5, 0.6] : medium sense of self-efficacy;
- ]0.6, 1] : high sense of self-efficacy.

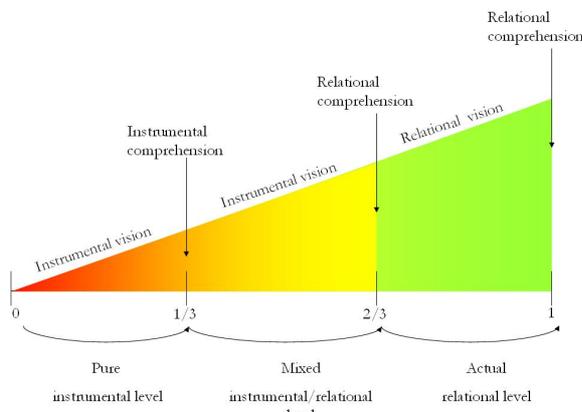


Figure 3. Axis of the view of the mathematics

*C. Axis of the emotional disposal*

The value on this axis represents "how much" the student likes mathematics, which can vary from 0 (nothing) to 1 (very much). A student with neutral emotional disposal is also represented on this axis. In the following we describe the three subintervals characterising our axis:

- [0, 1/4]: very negative emotional disposal;
- ]1/4, 1/2] : negative emotional disposal till indifference;
- ]1/2, 3/4] : positive emotional disposal;
- ]3/4, 1] : very positive emotional disposal.

Besides the representation of the affective student profile in the affective space, we can see from the fig. 1

that we have inserted from one hand, nearby the emotional disposal, the feelings associated by the learner to the mathematics, from the other hand, nearby the sense of self efficacy, the causes ascribed by the student to his/her failure in mathematics, which in our model will going to give information linked to the learner that will be used in order to design and offer the suitable recovering actions. In particular, we are interested to the causes and to those feelings which can be felt as stable with respect to mathematics (i.e. not linked to sporadic failure). This is because the aim of the recovering activities will be to remove the factors that the student perceived as causes of his/her failure.

Note that Weiner [15] have outlined that the causes ascribed to the success or the failure can differ according to various dimensions:

- locus: he distinguish between external and internal causes (e.g. "to be able" has been considered an internal cause, whilst the "help obtained by other people" is an external one);
- steadiness, with respect to time: e.g. "to be lucky" is not steady;
- controllability: the engagement is considered controllable, whilst the difficulty of a task is not).

These distinctions appear fundamental to the aim of modifying the profile of a learner and improve his/her outcomes: it is sufficient to bring on changes in the causal attributions and the effect will be, by suitable interventions, to move the causes from internal and steady ones (e.g. to "be not able") to external, not steady and controllable ones (e.g. the engagement), so to increase motivation and persistence with respect to the objective. More in general, Zan [16] states that the best way to intervene and remove the causes of such failure is to "suitably" develop the meta-cognitive skills, i.e. management of own cognitive resources.

III. A TOOL FOR ASSIGNING THE AFFECTIVE STUDENT PROFILE: THE QUESTIONNAIRE

As the attitude towards mathematics is strongly influenced by the learner's experience with mathematics, there is no doubt that the best way to investigate such topic is the composition. Zan has examined a lot of compositions, at any school level, describing the history of the relation between the student and mathematics. This way is the best one from the viewpoint of the research, because the risk of forcing an answer in one or another direction chosen by the researcher is avoided [6]. Anyway, it is not practicable in an ordinary management of a classroom and more and more in a e-learning management. On the contrary, questionnaire are well managed by means of technological tools. Thus, trying to take into account both methodologies, we have decided to create a mixed questionnaire, aimed to investigating on each of the three items of the model. The questionnaire is composed by some close questions, whose answers can be easily foreseen and classified, and some open questions which avoid the risk of forcing the answer. In fact the only close questions will not avoid the risk of forcing the answers; on the other hand the only open questions are not necessarily "understood" by the platform. They are managed using a database (created with the answers

collected during a test of the platform) which could fail in their interpretation.

According to the model, the questionnaire (shown in the following) reflects the three cited dimensions: the emotional disposal associated to the mathematics (questions 1, 2, 14); the view of mathematics held by the learner (question 8/10,14,15); the sense of self-efficacy (questions 6,7/9,11).

Further questions have been inserted as control keys: questions 3, 4, 5 allow a control on the crossed data derived from emotional disposal and vision; questions 12 and 13 allow a control on the crossed data derived from self-efficiency and vision.

Let us have a more detailed look at each specific questions and the role they play to build up the profile.

1. *Do you like mathematics?*
  - a. *No, not at all!*
  - b. *No... just a little bit.*
  - c. *Uninterested*
  - d. *Yes, I do enough.*
  - e. *Yes, I do very much!*
2. *Which sensations do you feel when you do mathematics?*
3. *When you do mathematics how much do you like the following activities?*
  - a. *To carry out exercise: not at all, not so much, enough, much*
  - b. *To solve problems: not at all, not so much, enough, much*
4. *What sort of exercise and/or problems do you prefer?*
5. *What sort of exercise and/or problems do you like less?*
6. *Do you think that you are successful in mathematics? Gives you a mark from 1 to 10:*  
(from 1 to 5., go to block B, otherwise go to block A)

#### BLOCK A

7. *What do you deduce that you are good at mathematics from?(you can choose a, b, or both)*
  - a. *I get good marks*
  - b. *when I do mathematics, I understand*
8. *How do you realise that you have understood?*
  - a. *I have correct outcomes*
  - b. *I correctly apply the rules*
  - c. *I can choose the rule to apply*

#### BLOCK B

9. *What do you deduce that you are not good at mathematics from?*
  - a. *I get bad marks*
  - b. *when I do mathematics, I don't understand*

10. *How do you realise that you have not understood?*
  - a. *I have not correct outcomes*
  - b. *I incorrectly apply the rules*
  - c. *I cannot choose the rule to apply*
11. *Your failure in mathematics is due to:*
  - a. *The subject*
    - *Why?*
  - b. *The teacher's didactical approach*
    - *Why?*
  - c. *Your difficulties*
    - *Which ones?*

#### (END OF BLOCK B)

12. *What do you think to be able to do with respect to a problem never seen before?*
  - a. *I think to be able to solve it*
  - b. *I think that I try to solve it even if I am not sure to be able to be successful*
  - c. *I think that I try to solve it, but maybe I abandon as soon as difficulties arise*
  - d. *I think to be not able to solve it*
13. *Do you think to be able to:*
  - a. *Carry out exercises*                      *Yes/No*
  - b. *Solve problems*                              *Yes/No*
14. *Choose three adjectives to describe mathematics.*
15. *In your opinion mathematics is:*
  - a. *A set of rules to apply to exercises all of same type in order to obtain correct answers*
  - b. *A set of rules to apply in different contexts*
  - c. *A subject which helps you to solve different problems*

The questions 1, 2 and 13 concern respectively the emotional disposal of the student towards mathematics. The first one will allow to split the students into five groups according to different emotional disposals: VN (very negative) corresponding to the answer a., N (negative) corresponding to b., I (uninterested) corresponding to c., P (positive) corresponding to d., VP (very positive) corresponding to e. Question 2 and 13, has the same role of the question 1 but they are open. The analysis of the open answers will be used to confirm or not the previous assignment. In particular, for the answers to the question 13, This will be done exploiting the categorization of the adjectives with respect to the emotional groups made by Di Martino et al.[6]. For question 2, an experimentation will be implemented so that the categorization of the most frequent emotion could be done. From a practical viewpoint, the e-learning platform will contain a database of the adjectives collected by Di Martino et al. and the emotion collected during the experimentation and the related categorization. It is obvious that some few new adjectives/emotions could arise, so a tool able to recognise the similarity will be used to assign a categorization label to those ones. This will allow an automatic management of the open question.

Regarding the sense of self-efficiency, question 6 allows us to get a first splitting of the students in ten groups according to the given answer. In this way the student will have the choice to assign a value to his sense of self-efficacy (e.g. from 0 to 10). The choice of having the grain fine, will give the possibility of observing the changes in a more sensible way, and this is important if we think this is one of the most important parameter.

Questions 7/9 goes into depth in investigating the learner's beliefs about his/her perception of self-efficiency sense. In particular, they allow to know "from which clues the student becomes aware he or she is/ is not successful in mathematics", thus representing an evidence of the causes he/she ascribes to his/her success or not. In particular, here there is a stress between internal causes (understanding) and external ones (marks).

Question 11 is open and allows us to have for each student a list of the causes he/she ascribe his/her failure in mathematics. We have distinguished three main blocks: the subject, the teacher and learners' difficulties: the student is asked to explain his/her choice. Thanks to the experimentation the causes will be collected, and classified in internal/external, stable/instable. In that way they will be used to build up the personalized learning path.

The two questions 8/10 and question 14 concern the vision of mathematics. The question 14 is a close question aimed to investigate the beliefs of the students on the subject. The options given for answer correspond to the three macro-level of the related axis in the affective space. The question 13 allow to confirm or not the previous answer. The adjectives, besides to be split into four groups, as already said, can be labelled as instrumental or relational one, giving indication on the position in the individuated macro-level.

Questions 3, 4, and 5 will be used as control of the tool by means of the coherence between the vision and the emotional disposal related to that vision. Question 3 allows a control on the crossed data derived from emotional disposal and vision (e.g. a student with positive emotional disposal and instrumental vision is expected to give positive answer to 3.a and negative one to 3.b); analogously for the questions 4 and 5, which allow the student to make clear his/her classification of exercises and problems with respect to his/her emotional disposal and vision. The non coherence could indicate a wrong interpretation of the questions on the students' part or an unreliability of his/her answer on the vision (e.g. if the vision is relational and at the same time he/she does not like the problems, it means that the question on the vision is not clear or the answer of the student is unreliable... it depends on the number of observed incoherencies). The 3 and 4/5 differ for the answer type (close and open) too, so 4/5 are used as control for 3.

Similarly, question 12 and 13 will be used as control of the tool by means of the coherence between the vision and the sense of self-efficacy related to that vision (e.g. a student with positive sense of self-efficiency and instrumental vision is expected to give positive answer to 13.a and negative one to 12 and 13.b).. They refer respectively to the capability of correctly performing a procedure, of understanding the meaning of a rule with respect to the context of usage, of managing their own knowledge in order to face "open problems".

#### IV. FROM THE QUESTIONNAIRE BACK TO THE MODEL

In this section we will describe which the affective profile consists of and how to set it, to the aim of implementing it in an e-learning platform.

According to the model given in the above section, we have a tri-dimensional space, represented by a cube of side 1. Each student, at any fixed time of his/her learning experience, can be identified by a point in the cube. In the following we will describe how to associated a point of the cube to a student, by means of his/her answers to the questionnaire. The questionnaire can be submitted again at subsequent times, then a picture of the student's emotional trend is available. According to the position of the student's point at any time, different activities can be devised.

The affective profile will consists of one numerical array  $v=(v_1, v_2, v_3)$ , as we will show in details in the following, and a matrix of the causes of the failure in mathematics individuated by the student, which will be used in order to choose suitable learning activities aimed to recover or prevent failure.

Let us consider the analysis of each element of the above arrays.

##### A. Analysis of the emotional disposal.

This analysis will give the value  $v_1$  of the first element of the array. It will be done taking into account the answers to the questions 1, 2, and 14. The first one will allow to split the students into five groups according to different emotional disposals: VN (very negative) corresponding to the answer a., N (negative) corresponding to b., I (uninterested) corresponding to c., P (positive) corresponding to d., VP (very positive) corresponding to e. A real value will be associated to each category: respectively from 0, 1/4, 1/2, 3/4 and 1, which will be initial values of  $v_1$ .

The analysis of the open answers to the 14 will be used to adjust the previous assignment. This will be done exploiting the categorization of the adjectives with respect to the emotional groups made by Di Martino et al.[6]. According to the adjectives chosen by the learner, the five categories individuated by Di Martino at all will be used, each of which will correspond to the integer values cited above: the average of such values will be considered as result, whose average with the first element of the arrays will be the new value of  $v_1$ .

The same will be done for the feelings associated to the mathematics: the answers to the question 2 will be classified into five groups, corresponding to the five item of the question 1.

##### B. Analysis of the self-efficacy

This analysis will give the value  $v_2$  of the second element of the array. It will be done taking into account the answers to the questions 6.

##### C. Analysis of the vision of mathematics

This analysis will give the value of the third element of the array. It will be done using the questions 8/10, 15 and 14.

The answers to 8/10 correspond to the instrumental, mixed and relational vision and the related values on the axis will be 0, 1/2, 1. The answer to 15 will be used as

control and the mean between the answer 8-10 and 15 can be considered.

The adjectives obtained by the open question 14 will be classified according to the instrumental, mixed and relational vision and such classification will be used as control to the close answer on the vision (8-10 and 15). If there is not coherence between close and open answers, we will consider the mean.

#### D. Further information

In order to complete the assignment of the profile, further questions will be used:

- question 11 will allow to write down a table of failure causes, which will be used to didactically intervene;
- the previous table will be enriched with those feeling (present in the answer 2) which are perceived as stable with respect to the mathematics (that is, not just linked to sporadic failure);
- the answer 3, 4, 5 will be used as control of the tool by means of the coherence between the vision and the emotional disposal related to that vision. The non coherence could indicate a wrong interpretation of the questions on the students' part or an unreliability of his/her answer on the vision.
- the questions 4/5 differ from 3 for the answer type (close and open), so 4/5 are used as control for 3;
- moreover, it has been noticed from the results of the questions 4/5 that often the students explicitly cite some typology of exercises, so a database of possible answers has been created, split into three categories, corresponding to instrumental, relational and mixed one;
- the answers to 12 and 13 will be used as control of the tool by means of the coherence between the vision and the sense of self-efficacy related to that vision.

#### V. HOW TO USE THE MODEL TO BUILD UP A TAILORED LEARNING PATH

According to the model, for each student we can individuate a point in the affective space, which represents at the moment his/her vision of the mathematics, how much he/she feels successful in mathematics and likes mathematics. Moreover the model for each student will contain two lists: one related to the feelings associated to doing mathematics, and one related to the causes felt for his/her failure in mathematics. How to use such information to improve learning in mathematics?

The student's point in the affective space allows to know:

- his/her perception of being successful or not successful with respect to his/her vision of the mathematics;
- his/her emotional disposal derived by the other two variables.

We recall that the cognitive, meta-cognitive and peri-cognitive levels are intrinsically linked. Thus the affective space gives also information to be used in choosing and presenting the students suitable cognitive and meta-cognitive activities to improve his/her success in

mathematics. More precisely the ordering on the axes can be associated to various teaching methodologies and contents' types.

The student's point in the affective space individuates a rectangular which represents the zone where the student is ok from the peri-cognitive level and then the zone where he/she feels and is successful in mathematics from the cognitive and meta-cognitive point of view too. The idea is to propose the students activities which are coherent with the zone near their affective rectangular, moving along one of the two directions given by the vision of the mathematics and on the sense of self efficacy. Experience shows that improving those two factors positively impacts on the emotional disposal, as a student affirm during an interview: «*Mathematics does not scare me anymore. Maybe, it is because I have got through the exam, but I saw it as a mountain, mathematics was a very difficult thing*».

Moreover as pointed out by the compositions examined by Zan & Di Martino, there are no cases such that the emotional disposal is the only one negative factor.

Between the remaining two dimensions, we choose to start the intervention taking into consideration the dimension corresponding to the minimum value (as coordinate of the point in the affective space).

Considering the view of the mathematics, according to the value obtained, the recovering activities will be aimed to pass from an instrumental view to a relational one, which means to pass from pure applications of rules and algorithms to the comprehension of the reasons of those applications and so on until the student becomes aware of what he/she is doing in mathematics and makes experience that he can "create" mathematics. Example of activities in such direction can be found in [16] and [2].

Considering the sense of self-efficacy, the tailored activities will be organised taking into consideration two factors:

- one given by the couple (vision, sense of self-efficacy) in order to choose the contents' type (e.g. (instrumental, low) suggests to involve the student in activities of exercise kind in order to enable the student to feel successful);
- another one given by a list of causes in order to choose the suitable methodology underlying the activities.

Let us give just some hints of activities.

With respect to the first factor:

- the value of the vision is used in order to choose among exercises, standard or non standard problems,
- the value of the sense of self-efficacy is used in order to give indications on the degree of difficulty of the activities.

With respect to the second factor:

- if the learner ascribes his/her failure to the difficulty of the topic, this means that he/she feel uncontrollable the cause of his/her failure; this means to put into practice interventions so to modify this vision and to move the cause to something felt as controllable (e.g. method of studying);
- if the learner ascribes his/her failure to mistakes he/she does, this means that he/she is not able to check the correctness of its products and then the

recovering path will be at meta-cognitive level aimed to allow the student to put into action foreseeing and control strategies on the process and the final and in itinere results;

- if the learner ascribes his/her failure to the worry of doing mistakes, it means that the student has a completely negative vision of the mistakes, this suggests activities aimed to recover the positive value of the mistake (i.e. the study of the mistakes and of their origin causes is exactly the starting point of the cognitive recover, moreover the tracing of the mistakes allows the learner to see his/her progress and then to increase his/her sense of auto-efficacy);
- if the learner ascribes his/her failure to the teacher, it means that the teaching style of the teacher does not match with the learning style of the student, and this implies to intervene changing the learning activities or objects in the learning path according to the learning style of the student.
- if the student see mathematics as an abstract subject, then a real-world based approach to mathematics may be suggested;
- if the student perceives some own lack of previous knowledge, then some personal support of a tutor and/or a personalised recovering learning path (both in contents and times) may be offered;
- if the student ascribes his/her failure to the teaching style, then different learning objects and activities may be given which better match his/her learning style;
- if the student feels a sense of frustration, it means that he/she has a global vision of his/her failure, then to take trace of his/her improvements (for instance e-portfolio) may help to overcome this negative feeling.

These are just some examples and suggestions, but more work is in progress in order to create a correspondence between affective profile, causes and tailored and recovering activities.

At the end of each intervention, investigation will be done in order to update the student's affective picture, that is his/her corresponding point in the affective space. The new point associated to the student after the intervention, will give us information about its efficacy and give us suggestion on how to proceed.

Some activities have already been designed and their experimentation have been started. In this first phase, it has been organised as following: the evolution of the affective profile of all the students have been studied according to the same activities carried out by everyone and it will be compared with the students' performance. The correlation among these three factors will be the basis for defining a correspondence between affective profile and activities promoting students' progress in mathematics. The outcomes of a first experimentation at the University of Piemonte Orientale (Italy) is in progress.

## VI. FUTURE TRENDS

We plan to go on with research on the design and experimentation of tailored learning paths, taking information of the affective profile of the students.

Some learning activities will be designed according to various profiles some of the found causes and implemented in a specific learning context in order to experiment them.

The already started study on correspondence between the list of the causes of the failure in mathematics and some actions/activities to be done in order to overcome the student's difficulties will be deepened.

The relation between the overcoming of learner's difficulties in mathematics and the evolution of the curves in the space will be also studied. The projection of the curves onto the three coordinates planes as well as the level curves will also be taken into account and it will be studied how to use the information they give in order to modify the learning activities.

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