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A STUDY ON COGNITIVE ASPECTS OF ASSESSMENT PRACTICES IN SECONDARY SCHOOL MATHEMATICS LEARNING

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Abstract- The validity of learning assessment tools is a determining factor in the relevance of the impact of this pedagogical act on the teaching-learning process. Mindful of the importance of this criterion, we conducted a study to explore the cognitive aspects of summative evaluation practices in secondary school mathematics. The aspects considered concern the levels of cognitive complexity, the types of mathematical activities and the frames used in the evaluation tests. Through an analysis of a corpus of mathematics tests proposed by secondary school teachers, we identify a clear domination of the use of the algebraic frame and of calculative activities while aiming at the first cognitive level according to the taxonomy of R. Gras. Several correlations between certain modalities related to the variables mentioned in our study were noted, but also oppositions between others were observed in certain cases, thus marking incoherence in the practices of elaboration of mathematics tests.

Keywords: Summative Assessment, Validity, Frames, Cognitive Levels, Principal Component Analysis.

1. INTRODUCTION

The concept of learning assessment is not at all new to those interested in education. However, it has not always carried the same connotation for all. It was seen by curriculum developers as a separate and distinct activity from the instructional planning process, while for the teacher it appeared more as an administrative task than an important pedagogical act. In recent years, teacher and student assessment activities have attracted increasing attention in all classes, as it can be remarked in [1] and [2] for example. This is due to three main types of reasons. On the societal level, there is a demand for a return on investment in education, and on the educational level, an understanding of the role of assessment in the instructional process is gaining momentum. Indeed, educators are increasingly aware of the need to ensure maximum quality in the assessment of learning for its impact on the future of students. On the administrative side, there is a greater belief in the need to separate instructional and administrative decisions in order to adopt more relevant modes of assessment.

These changes in position have led all the concerned actors to consider seriously the issue of assessment of learning and to give it an appropriate place in curricula. In this respect, an institutionalization of the reflection on the assessment of learning has emerged in several countries. Thus, structures have been created such as the National Council of Teachers of Mathematics in the United States, the Association for Achievement and Improvement through Assessment in the United Kingdom, the "Observatory for the Evaluation of Mathematics Programmes" in France and the "National Instance for the Evaluation of the Education, Training and Scientific Research System" in Morocco. These institutions produce influential study reports and resources on the approach to evaluation and its practices for researchers and practitioners. Many efforts have been made to define the meaning of evaluation. Within this framework, different types of evaluation have been distinguished according to the objectives of the evaluator, and even of the evaluated in the case of self-evaluation. Several educational researchers [3] have helped to clarify the nature of each type of evaluation and to develop its impact on education and training [4].

Initially, research on evaluation focused on national or international external evaluations [5]. Later, interest began to be shown in the local dimension of evaluation. In particular, reflections on didactic approaches to evaluation are emerging. Thouin [6], in his work on evaluation in mathematics, which is part of a constructivist perspective, considers that the study of students' cognitive patterns and the evaluation of their learning cannot be done without recourse to didactics. He thus refers to the three types of difficulties faced by students (conceptual difficulties, epistemological obstacles and didactic errors), which were identified by Vergnaud [7] in order to construct diagnostic instruments enabling him to measure and evaluate students' mathematical learning in elementary school. All assessment entails the collection, interpretation and communication of data [8]. The primary aim of these processes is to report conclusions as accurately as possible about the knowledge, skills and competences acquired by students. The way in which these processes are undertaken and conclusions drawn is crucial to the quality of an assessment, which is usually expressed in terms of the concepts of validity and reliability.

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In their study, Grapin and Grugeon-Allys [9] highlighted the positive contributions of a didactic and psychometric approach for promoting the quality of an external evaluation and in the institutional exploitation of the resulting data. In this context, the present work attempts to describe the state of implementation of the criterion of validity in terms of cognitive aspects in summative assessment practices among secondary school mathematics teachers. Two main objectives motivate this work. On the one hand, to obtain an inventory of teachers' practices in terms of learning assessment, in order to better study the repercussions of these practices on learners' activities, and on the other hand, to use the results for professional training ends.

In connection with our problem, we state the following questions:
1. What place do cognitive activities occupy in the development practices of summative evaluation tests of learning in mathematics in secondary school?
2. Are there links between the different cognitive activities implemented in summative assessment tests?

To answer these questions, we will conduct a principal component analysis. But at first, we will start by providing a review of the literature in order to clearly define our problem and to delimit its conceptual framework for the establishment of an adequate experimental protocol.

2. LITERATURE REVIEW

Studies on the topic of learning assessment are fairly abundant. In this summary, we will limit ourselves to works that contribute to the integration of assessment into the educational process. Within this context, we owe to Scriven [10] for being the first to use the expression formative assessment to describe the evaluation processes that play a role in the continuous improvement of the curriculum and to distinguish between summative and formative assessments. This distinction was also made by other authors, who emphasized the impact of formative assessment integrated into the learning process on the improvement of student learning, regardless of the discipline. For Black and Wiliam [11], the notion of assessment refers in a general context to any activity implemented by teachers and their students that provides information to be used as feedback to modify teaching and learning practices. Such assessment is termed formative when its results are used to adjust teaching to students' needs.

Summative assessment assesses students at the end of a teaching or training process. Brookhart et al [12] show the impact of summative assessments on student motivation. From a curricular perspective, Taras [13] considers that summative assessment measures the level of achievement of predefined standards, tasks, or objectives by gathering all the information collected up to a given point in time. In summative evaluation, this information can be collected in a variety of ways. By administering tests or examinations, summarizing observations and records retained during the learning period, creating a portfolio of work, including special tasks in regular activities, carrying out computerized tasks, etc. a combination of these methods.

In [13], the author emphasizes the interdependence of these two types of assessment for the pedagogical function of one and the certifying function of the other. Similarly, Wiliam [14] rejects any distinction between formative and summative assessment to the detriment of student learning and calls for the adoption of a systemic approach to assessment that follows a cycle of three phases: Elicitation, Inference and Action. The first phase concerns the collection of information from different types of assessment, the second the interpretation of this information, while the third refers to the actions that the teacher must take following the two previous phases. In this movement of research, authors have focused their interest on evaluation and grading practices. Brookhart [15] concluded that these practices lie at the intersection of three professional functions: teaching, classroom management and assessment. Shepard [16] considers that teachers' evaluation practices were not always very consistent, particularly with their beliefs, and that it was important to work to change them.

For Suurtamm and Koch [17], teachers face four kinds of dilemmas when evaluating their students' learning. It is:
- Conceptual dilemmas: why should we evaluate? what is the meaning of evaluation? What is the place of assessment in teaching and learning?
- Pedagogical dilemmas: how to evaluate? what strategy to adopt? what tools to use?
- Cultural dilemmas: how to adapt to new trends in evaluation prescribed by the institution or the context?
- Political dilemmas: what influence do national or international standardized assessments have?

In order to overcome the dysfunctions observed, or even failures, Brookhart [15] proposes to develop a specific theory of assessments based on three disciplinary fields: cognitive psychology, socio-pedagogy and the study of measurement. Thus, the criterion of validity of assessment tools is essential given its importance in understanding the effect of assessment practices on student learning. In the following section, we will delimit the meaning of the notion of validity, which is the subject of numerous definitions and discussions in several different scientific fields that are interested in assessment.

In mathematics, Van den Heuvel-Panhuizen [18] calls for an evaluation where the content, methods or even instruments used must all be part of a didactic perspective. This point of view has been taken up by the same author with Becker, who advocates that assessment in mathematics should be concerned with both the students' responses and their procedures. In other words, assessment should be based on didactics of mathematics and not only on psychometrics. To consolidate the didactic dimension in mathematics assessment, Thompson and Kaur [19] suggest that for any subject area, teachers should provide tasks that assess students' mathematical knowledge along four dimensions: algorithmic and procedural skills, properties of the knowledge involved, applications, and different representations. It is in this multidimensional framework that the present study is situated. Thus, we will need to clarify some concepts of didactics and psychometrics.

3. CONCEPTUAL FRAMEWORK

In this section, we outline the main concepts that will be used in the development of the data collection tools and in the discussion of the results obtained. Since the present work attempts to contribute to the improvement of evaluation practices through a reflective approach to the criterion of validity, we begin by defining the meaning of this concept. Its operationalization invites us to present tools from cognitive psychology and mathematics didactics.

3.1. Validity of an Assessment

Originating from the field of psychometrics, validity is considered in the teaching context to be one of the necessary criteria for a quality assessment. For several authors, [20] among others, validity represents the degree of adequacy between what one declares to evaluate and what one actually does, between what the tool measures and what it claims to measure. In a unitary view Messick proposes that the concept of validity should be seen as an integrated assessment of the degree to which empirical justifications and theoretical bases sustain the accuracy and relevance of interpretations and decisions based on test results or other modes of assessment [21]. It is within this functional framework that Moss [22] also conceives of the validity of classroom assessments, emphasizing its usefulness to teachers. In the same direction, Brookhart [23] calls for a rethinking of validity so that classroom assessments provide information about students' knowledge that can be used immediately to advance the course. An immediate question arises. How do we ensure the validity of an assessment?

According to [24], the validity of a test is based on the following elements:

- The relevance of the test content to the construct being measured.
- The cognitive processes involved.
- The internal structure where we are interested in whether the relationship between the items and the components of a test is consistent with the usual manifestations.
- The connection between test results and other variables not related to the test.
- The inference of interpretations that can be deduced from test results to other contexts.
- The consequences of interpretations and actions resulting from test results.

In this paper, we limit ourselves to the cognitive dimension in the assessment through three main aspects. These are the cognitive level, the type of mathematical activity and the knowledge processing framework involved in the learning assessment situation. The description of each aspect and the modalities associated with it will be detailed in the remainder of this literature review.

3.2. A Taxonomy of Cognitive Targets

In order to study a subject in activity, various works have been undertaken to elaborate classifications of tasks according to the aptitudes that the subject must mobilize to perform them. In this field, the work of Bloom et al [25] is an essential reference that continues to be developed for greater relevance and adaptation to different disciplines. For mathematical activity, Régis Gras developed a taxonomy of cognitive objectives. This work, which is aligned with Bloom's work, aims to operationalize the objectives attributable to mathematics teaching and to classify them according to the level of difficulty of the mental operations required by the pupil to carry out the tasks asked of him. Régis Gras mainly distinguishes the following categories of objectives [26]:

- Knowledge of the tools for grasping mathematical facts.
- Analysis of mathematical facts and transposition.
- Understanding of relationships and structures.
- Synthesis and creativity.
- Criticism and evaluation.

Inspired by the work in R. Gras [26] and the Program for International Student Assessment (PISA) created by the Organization for Economic Co-operation and Development (OECD), Bodin [27] developed a taxonomy that aims to analyze mathematical tasks according to a hierarchical order of cognitive levels. He distinguishes the following five general categories: knowledge and recognition, comprehension, application, creativity and judgment. Each level requires the mobilization of the previous levels.

In our study, the cognitivist aspect will be based, among others, on Antoine Bodin's taxonomy [27]. The identification of each category is explained later in the section dedicated to our research methodology. In parallel with the taxonomy of cognitive objectives specific to mathematics, R. Gras has developed a typology for mathematical activity [28]. These are the following ten types: heuristic, translational, classificatory, computational, logical, technical, reinvestment, creative, critical and predictive. Each type of activity is characterized by action verbs that will be specified in Table 2 in the following section.

3.3. Interplay between Frames

From a cognitivist point of view, R. Douady in [29] considers that the effective and efficient formation of mathematical knowledge can be achieved by bringing into play the tool-object dialectic in appropriately chosen settings invested in problems meeting certain conditions. By object, Douady refers to the cultural status of knowledge as part of a wider field of socially recognized scholarly knowledge [29]. Thus, the qualifier object refers to the formal aspect of knowledge. For the same author, knowledge is qualified as a tool if interest is focused on its use to solve a problem.

According to [29], a frame can be formed by the objects of a certain mathematical domain, their various possible semiotic representations, the relations that unite these objects and the mental images which correspond to these objects and their relations. A frame is used in the broadest sense of the term. It also covers a field of knowledge that does not necessarily belong to mathematics. Indeed, each frame brings into play specific concepts, and consequently obtains diversified formulations of a problem that are not necessarily totally equivalent. This diversification is cognitively important, as it enables the learner to access the difficulties encountered in the initial formulation and investment of new tools and techniques in a different way.

In the teaching-learning process, these exchanges between different frames are voluntarily put into practice on the teacher's initiative to concretize the tool-object dialectic in order to give meaning to the targeted mathematical objects. From an epistemological point of view, this conversion is imposed by the origin of the problems that mathematics seeks to solve. The notion of differentiability is an illustration of this. In fact, the central idea of its advent is of geometrical origin, and the first tests of its formalism come from certain intuitive methods which were frequent in the study of certain phenomena of physics under the name of fluxion. Consequently, the acquisition of the precise meaning of this concept and its applications can only be the fruit of its investment in situations from different disciplines. In other words, the formation of a concept's meaning depends on its treatment as a tool.

4. METHODOLOGY

In the following, we present the basic steps on which we based the experimental part of this work. The main objective of our study is to explore the assessment practices of secondary school mathematics teachers. To this end, we administered an analysis of tests proposed by mathematics teachers to students in the final year of experimental science (17-18 years old) during the 2021-2022 school year, as part of the first summative evaluation.

4.1. Sample Analyzed

Our analysis will focus on a sample of evaluation tests proposed by teachers working in the twelve regional education and training academies who agreed voluntarily to provide us with copies of their tests taken with their students in class. We collected five tests for each academy, divided into two different provincial directions. The sample of tests that will be analyzed is thus made up of 60 units. By referring to the institutional prescriptions relating to the instruction of mathematics at secondary school in Morocco [30], the first summative evaluation at secondary level must relate to the continuity and derivability of a numerical function with one real variable. The abilities targeted by the evaluation are presented in Table 1. It is important to note that the acquisition of the abilities targeted in the two courses (Table 1) requires an acceptable level of mastery of several types of mathematical activity as well as the ability to perform tasks of different cognitive levels.

From Table 1, it is also clear that the teaching of the two notions of continuity and derivability requires a treatment in several frames in the sense stated previously.

Table 1. Institutional framework of the study

Part of the course	Abilities
Continuity of a function	- Study of continuity at a point or on an interval. - Determination of the image of a segment or an interval by a continuous and strictly monotonic function. - Application of the intermediate value theorem in the study of some equations and inequations or the study of the sign of some expressions... - Use of the dichotomy to determine approximate values of solutions of equations of the form $f(x)=\lambda$ or to frame these solutions. - Application of the intermediate value and the bijection theorems in the case of a continuous and strictly monotonic function on an interval.
Derivability	- Study of the derivability at a point or on an interval. - Calculating the derivatives of usual functions. - Determination of the monotonicity of a function from the sign of its derivative. - Determining the sign of a function from its table of variations or its graphical representation. - Determining the monotonicity of the reciprocal function of a continuous and strictly monotonic function on an interval. - Mastery of the calculation of rational powers. - Determine the derivative of the reciprocal function of a function at a point. - Solving problems concerning minimum and maximum values.

4.2. Data Collection Tool

Data collection will be carried out by classifying each question in each test according to the three cognitive aspects: types of mathematical activities, frames involved and the levels of cognitive complexity involved in the formulation of this question and required for the production of responses by the student. In the light of the bibliographical review carried out and taking into account the cognitive conditions required for the achievement of the capacities of the Table, we have drawn up a grid (Table2) which gives the modalities related to each of the three cognitive aspects. For reasons of operationality of the classification of each question in the corpus of tests, a characterization is provided for each modality in Table 2.

4.3. Tools for Analyzing the Results

To ensure the validity and reliability of the measurement scales used, we will proceed in two stages. Firstly, principal component analysis (PCA) seems to us to be an effective tool for analyzing and interpreting the results of the analysis of the tests in terms of the links that exist between different items in our analysis tool [31]. PCA is a method of multivariate descriptive statistics that allows simultaneous treatment of any number of quantitative variables, several individuals measured against a large number of numerical variables. These variables are usually correlated with each other. PCA consists of searching for a limited number of factors by summarizing the data considered as well as possible. It results in graphical representations of the data (both individuals and variables) in relation to these factors illustrated by axes. These graphical representations are of the scatter plot type.

Table 2. Cognitive Analysis Grid

Modalities of the cognitive aspect	Characterization of the modality
1. Type of activity	Action verbs identifying the type of activity
Heuristic	Calculate, count…
Translational	Translating, representing, schematizing
Classificatory	Classify, organize
Computational	Prove, deduce, demonstrate
Logical	Take care of a calculation, a drawing, be precise and organized
Technical	Search, give hypotheses
Reinvestment	Illustrate, build a model
Creative	Create, give examples, invent
Critical	Evaluate, criticize, find counter examples, validate, invalidate
Predictive	Predicting, conjecturing
2. Type of the frame	Identification of the frame
Algebraic	Involvement of algebraic expressions defining functions or activities which are calculative only.
Graphical	Use of function curves to formulate the data, the question or to produce the required answer.
Numerical	Approximation of values.
Geometric	Use of geometric concepts (straight lines, tangents, semi-tangents, parallelism, etc.)
3. Cognitive level	Description of the level
Knowledge and recognition	This category is about knowing how to say, identify, recognize, apply "automatically". This level does not necessarily involve understanding.
Understanding	One knows how to explain, interpret and relate. A demonstration or the application of a procedure consisting of a single step remains at this level.
Application	This level involves understanding, which requires analysis and reflection. This level can leave the mathematization partially or totally to the student.
Creativity	This level requires prior analysis, experimentation, accumulation of indices. It is not a question of guessing or recognizing, but the sense of intuition is involved.
Judgement	Be able to evaluate and self-evaluate, choose a method of resolution, criticize a procedure or a proof, construct counter-examples.

The fact of having several items in our grid is positive for the measurement of all aspects of the variables mentioned in the study, but it may obscure the results considered essential to the study. Thus, we first perform a test of sampling adequacy to determine the relevance of the data to be analyzed. We will use the Kaiser-Meyer-Oklin (KMO) index, which is generally acceptable if its value is greater than or equal to 0.5.

Secondly, we will carry out the Bartlett’s test of sphericity, which provides the statistical probability with significance level of 5%, that the correlation between the items in the grid is different from zero. Finally, to check the internal reliability of our measurement tool, we used Cronbach's alpha index, which is an indicator that measures the reliability of the various items that are supposed to contribute to measuring a phenomenon. Reliability is acceptable if Cronbach's alpha is above 0.7.

5. RESULTS

The quantitative results of the classification of the questions of the tests according to the different modalities (Table 2) relating to the different aspects of cognitive activity are presented in Table 3. In this table, we have retained only modalities that did not have a zero score.

Table 3. Classification of test questions by cognitive activity

Modalities	Numbers
Classification according to cognitive levels	
Knowledge and recognition	635
Understanding	183
Application	92
Classification according to the proposed mathematical activity	
Computational	347
Classificatory	327
Translational	158
Technical	17
Classification according to question formulation frames	
Algebraic	739
Geometric	46
Graphical	104

5.1. Validity and Reliability of Measurement

In our study, the individuals are the 60 evaluation tests and the variables are the different modalities related to each of the three cognitive aspects. The analysis of the results obtained was carried out using the XLSTAT software (version 2022.3.1). Let us recall that our analysis grid is made of 19 items related to the three cognitive aspects, the algebraic framework, the cognitive level and the type of mathematical activity. We specify that, taking into account the fact that not all the modalities of Table 2 appear in the collected results, our principal component analysis was effectively carried out only on 9, discarding the modalities which gave a null score for all the tests and the technical modality, given its rather low score. Table 4 summarizes the results of the PCA on validity.

Table 4. KMO Index and Bartlett Test

Kaiser-Meyer-Olkin index	0.541
Bartlett's test of sphericity	
Khi² (Observed value)	446.893
Khi² (critical value)	50.998
df	36
p-value	< 0.0001
Sig	0.05

We can then conclude that:

- Since the KMO index is greater than 0.5 then all 9 items are factorable.
- The Bartlett test revealed that the calculated p-value is below the 0.05 level of significance.

Therefore, the hypothesis that there is no correlation significantly different from 0 between the variables should be rejected and the fact that there are correlations that are not all equal to zero should be retained. By specifying that the PCA is run on all the items without specifying the number of factors requested, we obtained the following results.

Table 5. Eigenvalues and variabilities

	Eigen value	Variability (%)	% Cumulative
F1	4.121	45.794	45.794
F2	1.734	19.264	65.058
F3	1.062	11.803	76.861
F4	0.921	10.232	87.092
F5	0.677	7.519	94.611
F6	0.288	3.199	97.81
F7	0.101	1.12	98.93
F8	0.058	0.65	99.58
F9	0.038	0.42	100

According to the Kaiser Criterion. only components with an eigenvalue greater than 1 are retained. Consequently. factors F1, F2 and F3 explain 76.861% of the total variance. The sum of their corresponding eigenvalues is 6.917. This means that these three components can replace 6.917 items. Note that the sum of the eigenvalues is equal to 9 (the number of items). On the other hand, the calculation of the Cronbach's coefficient gave the value 0.837. Hence, the reliability of our test analysis grid is satisfactory. Thus, all the items contribute to the reliability of our scale and no purification of the scale is required.

5.2. Results on Variables

For the interpretation, we will focus on the first factorial plane formed by two axes representing the factors F1 and F2 since they concentrate most of the information which corresponds to 65.058% of the variability. It is important to remember that the factorial axes are virtual, resulting from a synthesis between the variables in the analysis. The circle of correlations on the F1 and F2 axes is shown in Figure 1. It corresponds to a projection of the initial variables onto a two-dimensional plane constituted by the first two factors.

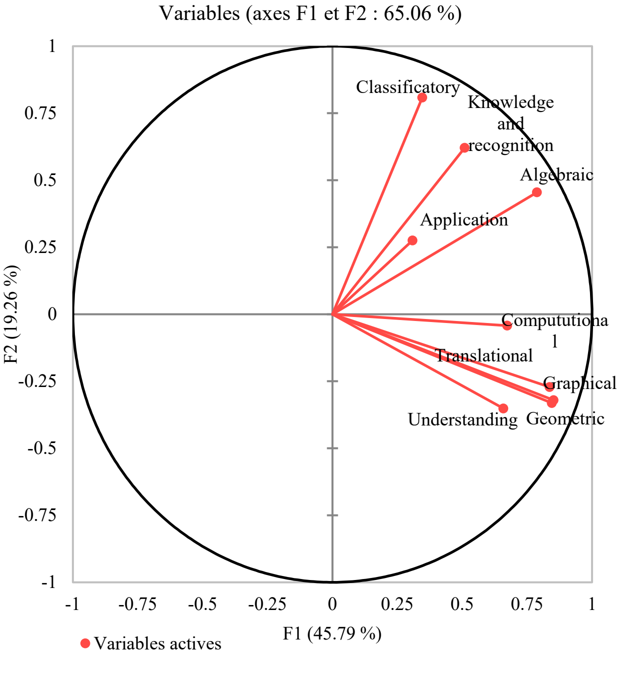

Figure 1. Circle of correlations

5.3. Results on Individuals

Figure 2 illustrates the results that correspond to one of the objectives of PCA. It allows individuals to be represented on a two-dimensional map. and thus, to identify trends.

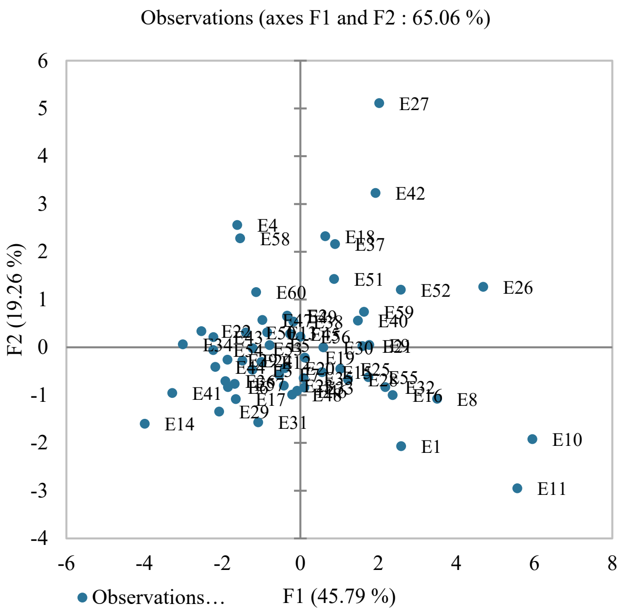

Figure 2. Graph of the design of individuals

6. DISCUSSION

The statistical data in Table 3 reveal a clear domination of the cognitive level of knowledge and recognition of the mathematical activities of calculation and classification and of the algebraic frame. It appears then, that the tests analyzed are focused more at measuring the students' ability to reproduce the disciplinary content than their cognitive performance in the two courses of continuity and derivability. The current study is based on the idea that teachers can consider a composite range of factors and that a clear understanding of these factors contributes to the development of mathematics tests presented in the summative assessment framework. By administering a PCA to a set of 60 tests several composite elements emerge. Focusing on axis 1 in Figure 1, we see that the first factor F1 is positively correlated with all of the initial variables. This correlation is quite strong with the algebraic, graphical and geometric frames. This means that if the frames are more involved in the tests then their scores are higher on axis 1. Conversely, if the frames are less involved the score is negative.

We also note that the points representing the classificatory type activities and the algebraic, graphical and geometric frames are the closest to the correlation circle and therefore very well represented. For the identification of axis 1, we can say that it represents, in a way, the group of dominant frames in the formulation of the questions of the tests analyzed. The rather acute angle formed by two variables indicates that they are fairly well correlated with each other. This is the case between several modalities. This means that for the tests analyzed, the involvement of the different modalities associated with the cognitive aspects evoked does not imply any non-correlation.

Some correlations between variables can be explained didactically. For example, the strong correlation between the algebraic frame and the cognitive level of application or between the translational type of activity and the graphical and geometrical frames are justified by the fact that the items of the tests propose a change of frames for the treatment of knowledge on the continuity and derivability of a function only after the execution of calculative tasks. Finding optimal values of a function is only requested after calculating the first derivative function. Similarly, the student is only asked to decide on the existence of tangents to a curve after calculating the limit of the rate of change.

On the other hand, the almost right angle formed by the classificatory and geometrical modalities indicates that these two variables are independent. This result seems to us to be well aligned with the fact that the tests analyzed do not propose any identification of mathematical objects through the direct implementation of a geometric approach. The classifications of mathematical objects required in all the tasks can only be achieved by a computational activity. To clarify this point, we cite the example of the question to write the equation of a tangent at a point on the curve of a differentiable function. It is only asked in the tests as a deduction from the algebraic study of the derivability. With regard to axis 2 in Figure 1, the classificatory modality shows a good correlation. The knowledge and recognition type also correlates well but to a lesser extent. These observations can be interpreted by the fact that axis 2 corresponds rather to the type of mathematical activity engaged in the test. Axis 2 also reveals an opposition between the modalities with positive correlations and those with negative correlations. Table 6 shows these oppositions by modality for each cognitive aspect studied.

Table 6. Opposite modality groups in relation to factorial Axis 2

Cognitive aspect	Modalities with positive correlations	Modalities with negative correlations
Cognitive level	knowledge and recognition. application	understanding
Type of activity	Classificatory, computational	translational
Implemented frame	algebraic	graphic. geometric

These oppositions that occur within the same domain of cognition question the practices of assessment test development. To provide more rigorous explanations for these aspects of inconsistency, our thinking goes directly to the dilemmas discussed in the work of Suurtamm and Koch [17]. We believe that conceptual and pedagogical dilemmas can provide insights. In Figure 2, we observe that the majority of the points are quite close to each other. This is interpreted by the fact that a large proportion of the analyzed tests deal with modalities of similar cognitive aspects. In our opinion, this can be explained by two considerations. Firstly, this similarity is aligned with our earlier remark that the diversification of cognitive activities and in levels of complexity is not taken into account in the design of the tests. In fact, several modalities in Table 2 are not covered by the tests analyzed. The second consideration is that the summative assessment is normalized by standards formulated in terms of program content, without any indication of the cognitive aspects.

However, it should be noted that some tests, for example E10, E11 and E27 escape this general trend. Their positions in the factorial plane show that they have particular characteristics because they come out of the cloud of points fairly concentrated around the origin of the marker. It is also important to note that the tests analyzed are strongly opposed with respect to axis 2. Therefore, having considered that axis 2 represents the type of activity involved in the test, our last statement means that the corpus analyzed can be divided into two groups that appreciate in opposite ways the implementation of the type of mathematical activity in the practice of elaborating the summative evaluation tests.

7. CONCLUSION

The evaluation of learning is a main lever for the quality of the teaching-learning process. Based on this awareness, numerous studies have been conducted on this pedagogical act. One of the major goals behind this work is to improve the validity of assessment tools. To achieve such a goal, it is necessary to take into account the cognitive domain in the practice of assessment in an efficient way. Thus, we set ourselves the problem of exploring the state of implementation of different cognitive aspects in the practices of developing high school mathematics tests. The cognitive aspects we considered are the result of the literature review we undertook. We planned to explore the types of mathematical activity. the knowledge processing frameworks and the level of cognitive complexity of a sample of mathematics tests proposed by secondary school teachers on the occasion of a summative assessment.

The principal component analysis conducted resulted in factorial axes with interpretations in terms of the dominant mathematical settings and activities in the selected corpus. Strong correlations were observed between several modalities related to the cognitive aspects studied. From the interpretation along axis 1, some correlations are explained by the compatibility of the mathematical activities required in the tests with the knowledge processing frameworks. Moreover, the domination of these two cognitive aspects has an impact on the level of cognitive complexity targeted in the test items. In this respect, let us mention the excessive recourse to the first level according to the taxonomy of R. Gras [26] which only requires an immediate restitution of knowledge in most cases.

Axis 2 indicated oppositions between certain modalities. This opposition remained unexplainable in the case where it concerned modalities relating to the same cognitive aspect. We conjecture that this is due to teachers' conceptions of the act of evaluation that may generate some inconsistencies as observed by Suurtamm and Koch [17] and Shepard [16]. This prompts us to conduct. for future research. a study on mathematics teachers' conceptions of the criterion of validity of learning assessment tools and on the modes of its implementation in the classroom. On the other hand, the present study limited to cognitive aspects in the assessment revealed a neglect of several cognitive activities. It would be very interesting to conduct a study to explore the main factors underlying this practice. Finally, it is necessary to state that improving assessment practices is an issue that needs attention and effort. From our study, it appears that a re-training of pedagogical actors in the field of assessment is urgently needed. In this context, we recommend starting with training on the issue of levels of cognitive complexity involved in a mathematical activity. The corpus analyzed showed that the interest given to this subject is unsatisfactory.

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