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ANALYSIS OF EFFECTIVENESS AND IMPACT OF INTEGRATING DIGITAL TECHNOLOGIES IN FORMATIVE ASSESSMENT

N. Zaibout [1] M. Madrane [1] L. Khamlichi [2] M. Laafou [1]

1. Interdisciplinary Laboratory of Research in Pedagogical Engineering, Abdelmalek Essaadi University, Tetouan, Morocco, nadir.zaibout@etu.uae.ac.ma, madrane2000@yahoo.fr, medlaafou@gmail.com
2. Preschool and Sports, Regional Academy of Education and Training, Ministry of National Education, Tetouan, Morocco, alikhamlichi@yahoo.fr

Abstract- Formative assessment refers to frequent interactive evaluations of students' progress and achievements to identify needs and adjust teaching accordingly. Teachers who use formative assessment methods and techniques are better equipped to address the diverse needs of learners by differentiating and adapting their pedagogy, ultimately enhancing student performance and equity in outcomes. Today, digital tools useful for assessment are becoming increasingly user-friendly and widely accessible. In fact, the evolution of technology drives the evolution of pedagogical approaches and educational activities. Along with this, assessment practices are also evolving. We are witnessing a proliferation of assessment forms and practices, ranging from the simplest to the most complex. In the Moroccan context, where access to digital technologies is improving, these results suggest that adopting such practices could not only enhance students' academic performance but also help reduce inequalities by offering more equitable and personalized learning opportunities, especially in rural and underprivileged areas.

Keywords: Assessment of Learning Outcomes, Digital Learning Environment, Formative Assessment, Digital Technologies, ICT in Moroccan Education.

1. INTRODUCTION

The term "assessment" inherently involves bringing out the value of a product created by a learner. To be effective, it must enable everyone to progress at their own pace. It is in this context that Ardoino (1976) supports this assertion by referring to it as a "process of meaning" [1]. In this study, our focus will be on the assessment process and the benefit of combining it with digital tools within a school learning pathway to enhance students' achievements. Our goal is to increase the diversity and relevance of various resources used in the assessment of learning. According to Caena and Redecker (2019), "the field of assessment deals with the use of digital tools to improve teachers' assessment strategies for students. These tools help teachers analyze, comment on, and plan assessment with the aim of providing targeted and timely feedback to learners" [2]. Additionally, in this study, the added value of assessment will also involve more easily collecting student data to provide them with quicker feedback and responses to their work.

Given that the advancement of digital technologies facilitates both learning and the assessment of achievements; can we say that digital tools are changing assessment practices? Do they diversify these practices? Do they enable innovation, enrich these practices, and even automate them? Can we say that digital tools expand and broaden their audiences while individualizing learning pathways? One is inclined to answer affirmatively to all these questions, while remaining cautious about viewing digital tools as the solution to all assessment problems. Does digital technology at least partially meet the expectations of a "good assessment" in a variety of contexts and for a diverse range of evaluators and learners?

- The expected outcomes of this study are:
- The use of digital tools in formative assessment significantly impacts learners' achievements due to the ease and variety of mechanisms (feedback), in contrast to classical formative assessment (traditional)?

2. THEORETICAL FRAMEWORK

What is meant by "digital"? As Milad Doueihi points out in his definition of "digital" [3], it is important to distinguish between computing and digital. Marcello Vitali-Rosati expresses a similar view, emphasizing, like other researchers, that digital does not merely refer to technological or computing tools, but rather to practices and worldviews that lead to profound societal changes associated with the use of the internet. Several authors present the digital as a "total social fact" [4], a concept developed by Marcel Mauss (1925). Applied to the digital realm, Pascal Plantard highlights that the use of digital tools and software transforms multiple dimensions of everyday life [5]. He draws on Serge Proulx's categorization, which identifies seven areas of daily life impacted by this phenomenon: "communication, politics, sociability, identity and subjectivity, cultural creation, human work, and the economy" [6]. Plantard also notes that the total social fact is "a bearer of rules and norms that gradually impose themselves on individuals" [7].

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In other words, practices, lifestyles, interactions, and more evolve alongside technological advancements. Jean-François Cerisier expands on this concept by introducing the notion of culture, which he calls the "total cultural fact". He defines the digital as "a set of techniques, equipment, software resources, but also usages, practices, behaviors, and values" [8]. This signifies the creation and transformation of an entire culture centered around one element: the digital. Indeed, the mass arrival of technological artifacts has given rise to a new culture -the digital culture- which plays a role in the evolution of societal structures. The digital has undeniably become an integral part of contemporary lifestyles: according to Julie Denouel and Fabien Granjon, "new technologies increasingly present themselves as an essential pathway for accomplishing more and more tasks in daily life. It is evident that these technologies have become central organizers of action" [9].

Digital cultures develop through the appropriation of these digital objects and services. "Appropriation," as defined by Serge Proulx, refers to "the creative integration of significant elements of this culture into the daily lives of users and communities" [10]. Technologies have evolved and become integrated into all spheres of society. Through their frequent use of technologies and their increasing numbers, users are driving the evolution of practices and organizations (task management, group dynamics, operational structures, etc.). These individual, then collective, movements give rise to new social norms and rules, which have continually evolved throughout history, just like societies themselves. The digital, therefore, marks our era and contributes to contemporary developments. It is defined as a social fact that impacts societal practices, values, and norms, and is not limited solely to the emergence or use of digital objects, platforms, or software.

2.1. Digital and Education

Digital technology in education is not merely about learning with digital tools. It goes beyond simply incorporating digital tools to learn various concepts from the curriculum or to know how to use platforms, software, or resources. The digital revolution disrupts, among other things, the relationship with time, spaces, knowledge, and by extension, entire educational systems.

Other knowledge and skills seem just as important as reading, writing, or arithmetic, with the aim of enabling future adults to integrate smoothly into our current societies. As the Organization for Economic Co-operation and Development (OECD) states: "Today, education is no longer just about delivering lessons to students, but about helping them create a reliable framework and the necessary tools to navigate confidently in an increasingly complex, unstable, and uncertain world". Today's teachers must help students think for themselves, work collaboratively with others, and develop their identity, agency, and goals" [11]. Indeed, technologies are developing exponentially and at an increasingly rapid pace, complicating an individual's ability to understand and adapt in a constantly changing world.

Within this digital dynamic, a vast array of online training resources has emerged, provided by public and private organizations as well as through personal initiatives by education professionals. In recent years, there has been a substantial growth in the availability of both synchronous and asynchronous online courses and training programs, accompanied by the emergence of online communities of educators who actively contribute to the evolution, exploration, and revitalization of educational practices.

These transformations do not rest solely on the shoulders of teachers, as all educational stakeholders have a role to play in adapting to societal changes. This includes actors at the macro level, such as the Ministry of National Education, Preschool, and Sports (MNEPS), as well as those at the meso level, such as regional education and training academies, provincial directorates, operators, and those involved in the initial or ongoing training of teachers (CRMEF).

2.2. Digital and Assessment

Assessment practices are also being questioned and evolving within this context of change. The definitions of assessment are varied. In a broad sense, assessment refers to "the act by which, regarding an event, an individual, or an object, a judgment is made based on one or more criteria" [12]. Digital technology paves the way for new methodologies and characteristics of assessment. This assessment can take various forms such as sound recording, multiple-choice questionnaire, text composition, film production, forum participation, concept map creation or a portfolio, and many other forms [13].

Communication channels among peers, teachers, learners-teachers, and teachers-families are diversifying and no longer exist solely within traditional learning environments. Self-assessment of one's practices can occur in the classroom, but also through the comparison of practices with peers who may be physically distant but cognitively aligned. For example, students can communicate with their classmates at any time while doing homework to seek help or ask questions. Access to information from home offers opportunities to better understand a concept or complete assignments. Learners can also compare their teachers' explanations with information found online. This shift leads to changes in the roles of teachers and trainers, who are no longer the sole sources of knowledge.

However, not all learners and teachers are equally equipped. While digital tools present an opportunity for some, they act as a barrier for others. Moreover, the use of a digital tool is not always straightforward: even if an individual is equipped, it is essential to support the appropriation of the tool before focusing on the pedagogical aspect. Alternating between in-person and remote learning, and incorporating new tools into educational pathways, requires the development of new practices as well as educational engineering that includes digital components.

2.3. Types of Assessments

2.3.1. Pedagogical Assessments

Pedagogical assessments encompass a range of methods and tools designed to measure and evaluate learners' knowledge and performance. These can include formal tests, quizzes, assignments, projects, observations, and other approaches to assess students' understanding and skills. The main objective is to determine what the class has learned and retained from the course. The results are used to improve course materials and adjust the curriculum as necessary [14].

2.3.1.1. Three Relevant Examples of Pedagogical Assessments

a) Formative Assessments: Formative assessments involve closely observing how learners engage with the material while providing continuous feedback. It is a collaborative process where teachers refine their teaching strategies, and learners enhance their learning journey.

- In other words, formative assessments: Highlight learners' strengths and areas that need improvement.

Help teachers identify learners' problem areas and address them promptly.

- Key Characteristic: Conducted during the course or training.

Formative assessments primarily involve carefully observing how learners engage with the material while providing continuous feedback.

b) Summative Assessments: Summative assessment is the final evaluation that measures the class's level of knowledge at the end of a course unit, based on a specific standard or benchmark. Summative assessments typically have significant weight and are often associated with a certificate or grade. Examples include exams, final projects, dissertations, or thesis defenses.

Key Characteristic: Conducted at the end of a course or training program.

c) Prognostic/Diagnostic Assessments: Prognostic assessments are preliminary tests designed to help teachers understand participants' strengths and weaknesses before starting the course. Occasionally, a similar test is administered after the course to assess whether participants have successfully met the course objectives.

- Key Characteristic: Conducted before the start of the course.

2.3.2. Psychological Assessments

A psychological assessment is an in-depth exploration of how a person or learner thinks, learns, feels, and behaves. It is like a toolbox filled with tests and procedures that create a comprehensive picture of an individual's functioning. More than just an evaluation, it is a personalized journey into the fascinating realms of the mind and behavior [15].

2.3.2.1. Two Relevant Examples of Psychological Assessments

a) Personality Tests: These tests serve a dual purpose: to create a dynamic profile of an individual's or learner's personality, or to highlight unique traits that define their character. They allow for exploring a wide range of personality dimensions: Dynamic tools are essential for helping learners achieve personal development goals, guiding educational and career paths, and improving team dynamics.

- Key Characteristics: Focus on individual traits, behavior prediction, and versatile applications.

b) Intelligence Tests: An intelligence test systematically assesses cognitive abilities and sharpness. It evaluates problem-solving skills, logical reasoning, memory, and other mental aptitudes, aiming to understand cognitive strengths and areas for improvement. By identifying these, educators can more effectively support learners in their development.

- Key Characteristics: Focus on individual cognitive abilities, assessment, and quantification of mental capacities.

2.3.3. Objective and Subjective Assessments

Educators employ two main methods to evaluate learners' progress: objective and subjective assessments.

Objective assessments-like multiple-choice and fill-in-the-blank questions-focus on specific facts and concepts. Grading is often based on a rubric or automated scoring system, ensuring fairness and consistency.

Subjective assessments, on the other hand, encourage learners to apply their knowledge and demonstrate critical thinking. These include essays, portfolios, final projects, or oral presentations, where the grading centers around the quality and depth of the learner's work, rather than on specific correct answers. Together, these methods assess both knowledge and practical application.

2.3.3.1. Three Relevant Examples of Objective Assessments

a) Multiple-Choice Questions: These tests evaluate a learner's knowledge and understanding of a subject by providing several possible answers for each question, with one correct option. This format is useful for formative, summative, or diagnostic assessments.

- Key Characteristics: Efficient, standardized, easily scalable, focused on knowledge assessment.

b) True or False Tests: In this type of test, learners are presented with statements and must decide whether they are true or false. This straightforward method assesses learners' factual knowledge and can also be used as a formative, summative, or diagnostic tool.

- Key Characteristics: Efficient, standardized, easily scalable, focused on knowledge assessment.

c) Fill-in-the-Blank Questions: This type of test presents learners with incomplete sentences, and they must fill in the missing words using their subject knowledge. It's a method for demonstrating understanding and can be applied as formative, summative, or diagnostic assessment.

Our current study will focus specifically on formative assessment and the contribution of digital tools to this type of assessment, for the following reasons:
1. Assess learners' achievements and ensure that digital tools can enhance understanding and correct mistakes instantly, without penalizing them.
2. Accelerate learners' progress by targeting specific skills, leveraging the precision, speed, and traceability that digital tools offer.
3. Ensure that regulatory feedback in digital learning environments can help learners improve, motivate them to advance in their courses, and maximize their chances of success.

3. MATERIALS AND METHODS

This section outlines the materials and methods employed to assess the impact of digital tools on formative student assessment in Moroccan schools. To guarantee the reliability and validity of the results, a combination of quantitative and qualitative methods was employed, such as an experimental design and structured interviews.

3.1. Methods and Means

Our study relies on two types of methods:
a. Quantitative Study: This method is used to prove or demonstrate facts by quantifying our study through results expressed in numerical data (statistics).
b. Qualitative Study: This method is more descriptive and focuses on interpretations, experiences, and their meanings based on observations and interviews. As for the means, we used:

3.2. Experimentation

We conducted a traditional formative assessment activity -paper-and-pencil tests (Group 1, comparison group)- based on the evaluation criteria and logistical and organizational resources in place. In parallel, we conducted a digital formative assessment activity using tablets (Group 2, experimental group) within a dedicated digital learning environment (Moodle), following the pedagogical and digital modalities described on the platform.

3.3. Structured Interview

Multiple-choice questionnaire (19 questions) based on formative assessment indicators aligned with Wiliam's five strategies [16]:
1. Clarification of the Goal and Sub-Goals (S1);
2. Assessment of Students' Current State (S2);
3. Progression feedback (S3);
4. Empowerment of students (S4);
5. Encouragement of Peer Interactions (S5).

As well as indicators of self-regulation of learning (cognitive, motivational, and emotional). This questionnaire will allow us to ensure that all individuals are questioned under the same circumstances. The results will be more easily comparable, and our statistical data analysis will be more relevant. This way, we can achieve theoretical saturation.

Table 1. Indicators of Formative Assessment Practices

Strategy	Indicators	Description
S1	Clarifications of Goals	Clarify the goals and intermediate sub-goals of the activity
	Success Criteria	Clarify the success criteria and the competencies being assessed
S2	Knowledge	Gather clues about prior knowledge
	Comprehension	Gather clues about the understanding of what is being asked
	Task Progress	Gather clues about the students' progress in the task
	Self-Assessment	Describe the success criteria and refer to them to help students understand their progress
S3	Progression Feedback	Clarify students' progress in tasks and their knowledge, highlight what remains to be done, and explain how to accomplish it
S4	Empowerment	Incorporate students' ideas, follow their initiatives, and allow a certain level of autonomy in their access to resources
S5	Group Discussions	Encourage discussion and argumentation within groups, emphasizing peers as a valuable resource
	Whole-Class Discussion	Consider students' suggestions within the class and encourage them to interact with each other regarding these proposals

3.4. Semi-Structured Interview

This method will be used to gather information that provides explanations or evidence to support our research work. To refute or confirm our working hypotheses formulated beforehand, and to draw conclusions on the subject we are studying, we conducted an experiment involving 106 students divided into 2 groups and 4 teachers, according to the following characteristics and modalities.

Table 2. Scope of the Study

Target Population	6th Grade Primary School Students and Teachers
Course/Subject	Puberty and Genital Organs / Science
Number of Participants	106 Students / 2 Teachers
Host School	Al-khawarizmi School, M'diq Provincial Directorate of the Ministry of National Education- M'diq-Fnideq

Table 3. Modality of traditional formative assessment

Steps	Modalities
Step 1: - Administration of the Pre-test - Delivery of the Lesson	- Administration of the Pre-test. - Implementation of learning activities for the relevant lesson in class using active pedagogy
Step 2: - Administration of the Traditional Formative Assessment Activity (Group 1: Comparison Group)	- Initiation of the Formative Assessment Activity: Teacher's Introduction the teacher explains the purpose of the activity, the learning intentions, and the success criteria - Distribution of Paper-Based Tests: The tests are administered according to the standard regulations and routines of the institution
Step 3: Correction of tests by the teacher	Correction of the Tests: The tests are graded according to predefined criteria, indicators, and a scoring rubric
Step 4: Scheduling a Correction and Discussion Session	- Collective Correction of the Test and discuss the errors made and the observed learning gaps - Emphasize the strategies for adjustment and reinforcement accordingly

In this article, our study will focus on the statistical analysis of the quantitative results from the assessments of the two groups of students (experimental group and comparison group). These results will be processed, analyzed, and interpreted using SPSS software, which offers a wide range of capabilities, from data preparation to data processing and analysis.

Table 4. Method of digital formative assessment

Steps	Modalities
Step 1: Administration of the Digital Formative Assessment Activity (Group 2: Experimental Group)	- Initiation of the Formative Assessment Activity: Teacher's Introduction: ** The teacher explains the purpose of the activity, the learning intentions, and the success criteria - Setup of Technological Devices: Smartphones, tablets, computers, and internet access, along with the digital learning environment (ENA), are prepared. - Administration of the Digital Test
Step 2: Adaptive Feedback (No Penalty)	The student can adjust their responses to each question, attempting to achieve the highest possible score through trial and error by adapting based on the feedback provided
Step 3: Review of Detailed Student Reports	Become aware of the progress made and be able to identify learning successes and failures

On the other hand, we will rely on the qualitative interpretations of the learners' responses to the post-assessment questionnaire to derive the expected outcomes. While our study provides valuable insights into the impact of digital technologies on formative assessment, it is important to acknowledge several methodological limitations that may influence the generalizability and interpretation of the results:

1. Sample size and representativeness: The sample size is relatively small, which may affect the generalization of the results to the entire Moroccan student population.
2. Selection bias and novelty effect: There is a risk of selection bias, as participants may be more familiar with digital technologies, and the novelty effect could have temporarily influenced students' performance.
3. Variability in practices and technological context: Differences in how teachers use technologies and unequal access to digital resources across different regions may limit the comparability and applicability of the results.

4. RESULTS AND DISCUSSION

This section presents and analyzes the results of our study on the integration of digital tools in formative assessment in Morocco. We explore the impact of these technologies on student performance and engagement, comparing our findings with existing literature. This analysis highlights the benefits and challenges of digital formative assessment, offering insights for improving educational practices. The descriptive statistics of the students' formative assessment results confirm our initial observation, namely that digital formative assessment significantly impacts learners' achievements due to the ease and variety of feedback mechanisms, in contrast to traditional formative assessment.

4.1. Statistical Data Analysis

4.1.1. Descriptive Statistics

Table 5. Descriptive Statistics Tests/Groups

Statistics	N_b of OBSR	Min	Max	Mean	Standard deviation
Pre-Test Score Traditional	53	0.50	7.25	2.967	1.226
Pre-Test Score Digital	53	1.00	5.00	3.085	0.951
Post-Test Score Traditional	53	2.58	10.00	6.282	1.622
Post-Test Score Digital	53	4.11	9.86	7.286	1.522

Table 6. Results of the Shapiro-Wilk normality test

Shapiro-Wilk Test	Pre-Test Score		Post-Test Score	
	Traditional	Digital	Traditional	Digital
W	0.911	0.973	0.980	0.970
p-value (bilateral)	0.001	0.260	0.515	0.204
alpha	0.05	0.05	0.05	0.05

4.1.2. Test Interpretation

- H_0: The variable from which the sample is drawn follows a normal distribution.
- H_a: The variable from which the sample is drawn does not follow a normal distribution.

Given that the calculated *p*-value is lower than the significance level *alpha* = 0.05 for the sample (traditional group Pre-Test score), we must reject the null hypothesis H_0 and accept the alternative hypothesis, H_a. The risk of rejecting the null hypothesis H_0 when it is actually true is less than 0.08%.

Given that the calculated p-value is greater than the significance level *alpha* = 0.05 for the other samples, we cannot reject the null hypothesis H_0. Since the majority of the samples follow a normal distribution, we should use a parametric test such as the student's t-test for two independent samples The Student's t-test for two independent samples is a statistical method used to determine if there is a significant difference between the means of two different groups.

4.1.3. Student's t-Test for Two Independent Samples / Two-Tailed Test (Pre-Test Score)

The 95% Confidence Interval for the Difference in Means [-0.540, 0.305]

Table 7. Results of the two-tailed t-test for pre-test scores of the two independent groups: traditional and digital

Difference	-0.118
t (Observed Value)	-0.553
|*t*| (Critical value)	1.983
DDL	104
p-value (two-tailed)	0.581
Alpha	0.05

4.1.4. Test Interpretation

H_0: The difference between the means is equal to 0.
H_a: The difference between the means is different from 0.

Given that the calculated p-value is greater than the significance level *alpha* = 0.05, we cannot reject the null hypothesis H_0. The risk of rejecting the null hypothesis H_0 when it is actually true is 58.11%.

4.1.5. Student's t-test for Two Independent Samples / Two-tailed Test (Post-Test Score):

The 95% Confidence Interval for the Difference in Means [0.399, 1.611]

Table 8. Results of the two-tailed t-test for post-test scores of the two independent groups: traditional and digital

Difference	-1.005
t (Observed value)	-3.288
|*t*| (Critical Value)	1.983
DDL	104
p-value (two-tailed)	0.001
Alpha	0.05

5.1.5. Test Interpretation

H_0: The difference between the means is equal to 0.
H_a: The difference between the means is different from 0.

Given that the calculated p-value is lower than the significance level *alpha* = 0.05, we must reject the null hypothesis H_0 and accept the alternative hypothesis, H_a. The risk of rejecting the null hypothesis H_0 when it is actually true is less than 0.14%.

5.1.6. Summary

Table 9. Summary of the Two-Tailed T-Test for Pre-Test and Post-Test Scores for the Two Independent Groups: Traditional and Digital

Variable / Test	Student
Pre-test Score	0.581
Post-Test Score	0.001

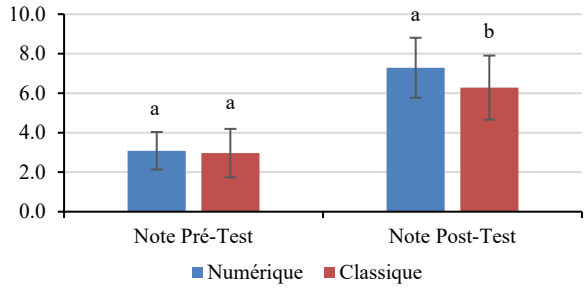

Figure 1. Graphical Presentation of the Difference Between the Average Pre-Test and Post-Test Scores for the Digital and Traditional Groups

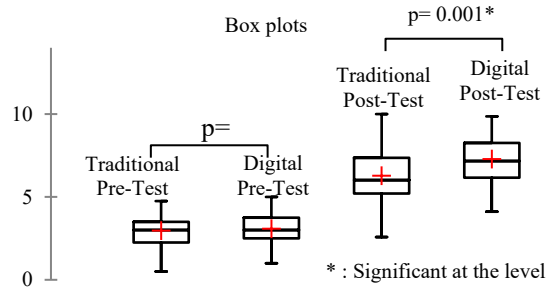

Figure 2. Comparison of Pre- and Post-Test Results Between Traditional and Digital Methods

4.2. Learning Regulation Through Multiple Attempts

4.2.1. Descriptive Statistics

• Repeated Measures ANOVA: Tracking the Progression of Scores Within the Group Across Different Attempts.

Table 10. Descriptive Statistics for Post-Test/Attempts

Variable	Obser	Min	Max	Mean	Standard deviation
Attempt 1	106	2.160	9.260	5.713	1.553
Attempt 2	106	1.400	9.660	6.373	1.841
Attempt 3	106	2.970	9.860	7.330	1.560

4.2.2. Repeated Measures ANOVA is Based on the Same Model as a Traditional ANOVA

The Model Equation is Given by:

$$Yijk = \mu + \alpha i + \beta j + (\alpha\beta)ij + \int jki$$

where, *Yijk* is the observed value of the dependent variable for the *i*-th subject at the *j*-th level of the first independent variable and the *k*-th level of the second independent variable, μ is the overall average of all observations αi is the main effect of the *i*-th condition (level) of the first independent variable, βj is the main effect of the *j*-th level of the second independent variable. $(\alpha\beta)ij$ is the interaction between the *i*-th level of the first variable and the *j*-th level of the second variable and $\int jki$ is the residual error associated with the observation.

In this equation, α, β, and $(\alpha\beta)$ represent the main effects and interaction, respectively, of the independent variables. The objective of repeated measures ANOVA is to determine whether these effects are significantly different from zero, which would indicate a statistically significant difference between the groups or conditions being tested.

4.2.3. Mauchly's Test of Sphericity

Given that the p-value is less than 0.05, we must reject the null hypothesis that the covariance matrix is spherical. To adjust for this violation, the Greenhouse-Geisser and Huynh-Feldt corrections were applied. The Greenhouse-Geisser and Huynh-Feldt epsilons were calculated. The closer these indices are to 1, the closer we are to a spherical matrix.

Table 11. Results of Mauchly's Test of Sphericity for Checking the Equality of Variances of Differences between Conditions in Repeated Measures ANOVA

DDL	Mauchly Statistic	*Khi²*	$P_r >$ *Khi²*	Greenhouse-Geisser Epsilon	Huynt-Feldt Epsilon
2	0.58411581	55.9162253	0.000	0.943	0.960

4.2.4. Tests of Within-Subjects Effects

The within-subject effects allow us to see the impact of repeated measures, and thus the attempts: we observe that the attempts have a significant impact on the students' scores (an increase in the average score after each attempt).

Table 12. Results of within-subjects effects tests in repeated measures ANOVA

Source	DDL	Sum of Squares	Mean Square	*F*	$P_r > F$	Adj. P_r>*F G-G*	Adj. P_r>*F H-F*
Repetition	2	140.101	70.051	77.973	< 0.0001	< 0.0001	< 0.0001
Error	210	188.664	0.898				

4.2.5. Multiple Comparisons

Repetition / Tukey (HSD) / Analysis of Differences between Modalities with a 95% Confidence Interval:

Table 13. Results of the Tukey (HSD) test for analysis of differences between modalities with a 95% confidence interval

Contrast	Difference	Standardized Difference	Critical Value	$P_r > Diff$	Significant
Attempt 3 vs Attempt 1	1.617	7.562	2.355	< 0.0001	Oui
Attempt 3 vs Attempt 2	0.957	4.083	2.355	0.000	Oui
Attempt 2 vs Attempt 1	0.660	2.821	2.355	0.014	Oui
Critical Value of Tukey			3.33		

Table 14. Significance Between the Means of Post-Test Attempts (Means with the Same Letter Are Not Significantly Different)

Modality	Estimated means	Groups		
Attempt 3	7.330 a	A		
Attempt 2	6.373 b		B	
Attempt1	5.713 c			C

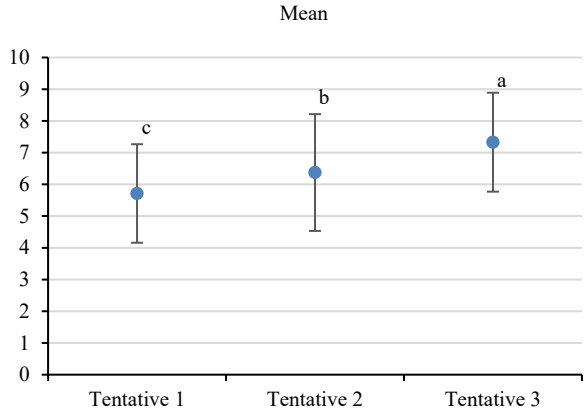

Figure 3. The Evolution of the Average Post-Test Scores with the Attempts

Based on the analysis of the students' results, we deduce the following observations:

a) The use of digital tools proves its effectiveness in formative assessment, as students' results were improved due to the ease and variety of feedback mechanisms, in contrast to traditional formative assessment.

b) The use of digital tools significantly impacts learners' achievements in formative assessment situations by allowing learning regulation through multiple attempts, which highlights the learners' strengths and the areas where they need to improve.

4.3. Interpretation of Qualitative Data

At the end of a multiple-choice questionnaire (19 questions) designed based on the indicators of formative assessment and grounded in Wiliam's five strategies, as well as indicators of self-regulation in learning (cognitive, motivational, and emotional), the following interpretations were made. We focus our analysis on six fundamental aspects of this experiment:

1. Students' progress in completing a task;
2. Students' self-assessment ability;
3. Students' engagement and activity;
4. The feedback timing and its impact on students;
5. The graded nature of the assessment and the pressure felt by students;
6. Students' self-perception regarding the assessment.

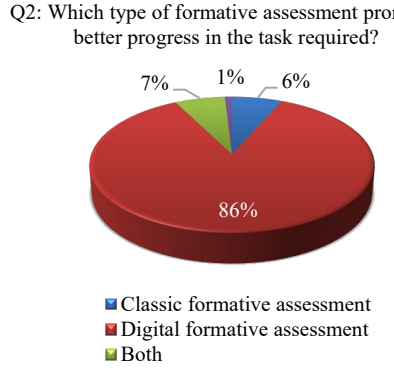

Figure 4. Type of formative assessment promotes better progress in the task required

86% of students believe that digital formative assessment promotes better progress in the task required, while only 6% think that traditional formative assessment is more effective. A small percentage, 7%, of students consider both types of assessment to be beneficial, and 1% do not favor either. The strong preference for digital formative assessment indicates that students perceive this method as more effective in supporting their progress in evaluative activities. This perception can be attributed to several inherent characteristics of digital tools.

Digital assessments allow students to receive instant feedback after completing a task, enabling them to immediately correct their mistakes and adjust their approach. Nicol and Macfarlane-Dick (2006) explain that this rapid feedback is crucial for self-regulated learning, as it allows students to proactively engage in improving their performance [17]. 96% of students prefer digital formative assessment to improve their self-assessment ability, showing strong support for this method. Only 3% of students prefer traditional assessment, and 1% see an advantage in combining both methods. This strong preference for digital tools may be attributed to their ability to provide instant feedback, personalized learning, and greater interactivity—features often highlighted in educational research. For example, Bennett and Lockyer (2004) emphasize that digital technologies facilitate "continuous and formative assessment," allowing students to better understand their progress and adjust their learning strategies accordingly [18].

Furthermore, Black and Wiliam (2009) note that formative assessment, when supported by digital tools, can encourage student autonomy and engagement by providing them with clearer and more immediate data about their own learning [19]. This is particularly relevant in the current context, where students are increasingly exposed to digital technologies and expect their learning to be supported by these tools.

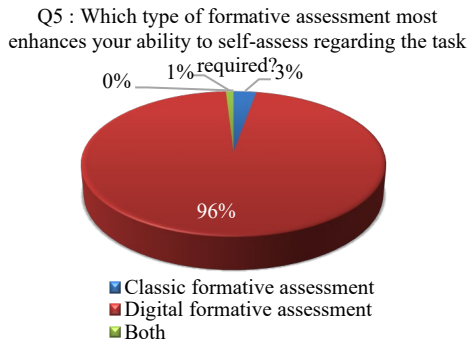

Figure 5. Type of formative assessment most enhances the ability to self-assess regarding the task required

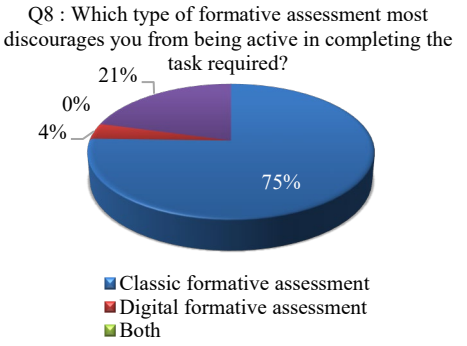

Figure 6. Type of formative assessment most discourages active engagement in completing the task required

The students' responses to this question highlight a notable difference between traditional formative assessment and digital assessment in terms of their impact on student activity. A significant majority, 75% of students, feel that traditional assessment makes them less active, while only 4% feel the same about digital assessment. These results suggest that digital formative assessment is perceived as more engaging and stimulating for students, offering opportunities to make the evaluation process more interactive and active.

In contrast, traditional assessment, often based on more passive approaches such as paper tests, focuses on memorization and the passive recall of knowledge, which may limit creativity, critical thinking, and active participation. Nicol's (2007) work supports this finding by emphasizing that the integration of digital technologies into formative assessment can provide faster and more personalized feedback, thereby enhancing student engagement [20].

Traditional formative assessment, which often relies on methods such as written tests, exams, and manually graded assignments, is perceived by 94% of students as taking much longer to provide feedback. This delay can be attributed to the time required for manual grading, compiling results, and delivering feedback to students.

The very low percentage of students, 5%, who find that digital assessment takes time to provide feedback highlights the efficiency of digital tools in delivering rapid responses. Digital assessment tools often provide near-instant feedback after completing a task, whether through online quizzes, interactive exercises, or automated grading systems.

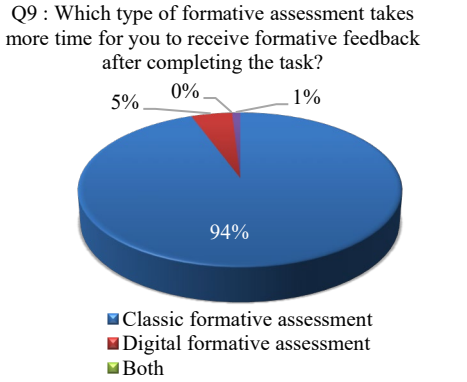

Figure 7. Type of formative assessment that takes the most time to provide formative feedback after completing the task required

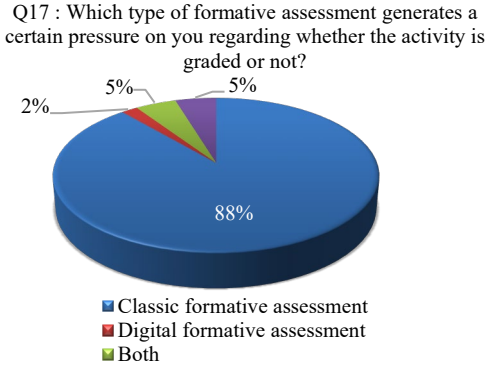

Figure 8. Type of formative assessment that generates a certain pressure regarding whether the activity is graded or not

The vast majority of students, 88%, feel increasing pressure when faced with traditional formative assessment. This pressure can be attributed to the conventional nature of traditional assessments, which are often perceived as more formal and closely tied to academic results. This can lead to anxiety and an excessive focus on grades rather than on improving learning outcomes. Only a small percentage of students, 5%, feel similar pressure with digital assessment. This suggests that digital tools may reduce the perception of pressure by providing a less formal and more flexible assessment environment. Digital assessments often offer immediate feedback, opportunities for repetition, and personalization, which can reduce performance-related anxiety. According to Sadler (1989), students' perceptions play a crucial role in how they experience assessment [21]. When assessment is perceived as a supportive tool rather than a judgmental one, students are more likely to engage actively and use feedback to improve their learning.

89% of students experience a positive self-perception when engaging in digital formative assessment activities, while only 2% feel this way with traditional assessment. Additionally, 9% of students report feeling this positive perception with both types of assessment. This can be attributed to the interactive and engaging nature of digital tools, which allow students to better track their progress and receive immediate feedback. The less formal nature of digital assessments may also reduce performance-related anxiety, enabling students to focus on their personal development and skill improvement.

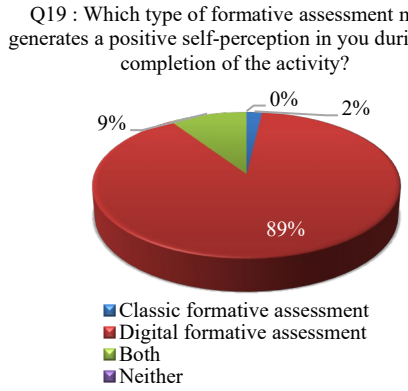

Figure 9. Type of formative assessment that most generates a positive self-perception during the completion of the activity

According to Laurillard (2012) and other researchers, digital tools often provide a more interactive interface, incorporating playful or visual elements that can make assessment less intimidating and more engaging [22]. Digital environments frequently allow for the personalization of the learning experience, tailored to the specific needs of each student. This personalization can lead students to feel valued and supported, thereby enhancing their positive perception of their own learning.

The results of our study are in line with those of previous research, such as Nicol and Macfarlane-Dick (2006), who demonstrated the importance of rapid feedback for self-regulated learning, and Black and Wiliam (2009), who highlighted the positive impact of digital tools on student autonomy and engagement. Furthermore, comparative studies, such as those by Bennett and Lockyer (2004), show that integrating digital technologies into formative assessment facilitates a more precise adaptation to the individual needs of students. These findings reinforce the idea that digital tools can significantly enhance the effectiveness of formative assessment.

4.4. Novelty Effect and Bias

The novelty effect and biases in students' results are factors that can distort the real evaluation of the impact of digital tools on learning. Below are some strategies we have adopted to control or mitigate them:

4.4.1. Novelty Effect

The novelty effect refers to the initial positive reaction of students to the introduction of a new tool or method simply because it is perceived as "new." This effect can temporarily improve results, but it does not necessarily indicate a lasting impact. Our study took into account three elements to ensure that evaluations are more representative:

a) Adaptation period: We implemented an adaptation period before evaluating the actual results. During this period, students familiarize themselves with digital tools.

b) Longitudinal measures: We conducted evaluations at different stages of the process (at the beginning, middle, and end of the usage period) to compare long-term performance. This helps to determine whether the initial results due to the novelty effect persist or not.

c) Control groups: We compared a group of students using the digital tool with another group that continued using traditional methods. We found that the performance gap was sustainable, making it more likely that the results were linked to the effectiveness of the tool rather than the novelty effect.

4.4.2. Bias Related to Familiarity with Technology

Biases can appear if some students are more familiar with digital tools than others, skewing the results in favor of technologically advanced students. Our intervention focused on three approaches:

a) Preliminary training: We organized equivalent training sessions for all students on the use of digital tools before the evaluation. This helped reduce the gaps in technological competence between students.

b) Evaluation of digital skills: We pre-assessed students' technological skills and adjusted the groups based on their level to ensure that the technological variable did not distort the results.

c) Gradual appropriation: We introduced the digital tools progressively to give all students time to adopt the new systems at their own pace.

4.4.3. Bias Related to Teachers

Teachers who are more comfortable with technology may unconsciously give additional guidance to students, influencing the results. Our intervention concerning teachers focused on two points:

a) Teacher training: We provided uniform training for teachers to ensure that they master digital tools and can use them equivalently for all students.

b) Standardized procedures: We implemented standardized protocols for the use of digital tools so that each teacher follows the same steps and does not alter the methodology based on personal preferences.

It is important to emphasize that the novelty effect and biases can be mitigated by adopting rigorous methods such as randomization, the establishment of control groups, preliminary training for teachers and students, and conducting long-term evaluations. This ensures that the results reflect the actual impact of digital tools on learning rather than contextual or temporary factors.

4.5. Cultural Context and Adaptation

The adoption of digital tools in the Moroccan education system is influenced by cultural and social factors that modify their effectiveness. In urban areas, technology is perceived as a vector of modernization, but in rural areas, resistance is stronger due to cultural values that favor traditional methods and limited infrastructure. This digital divide exacerbates inequalities in access to technological tools, reducing their effectiveness for disadvantaged students [23].

Moreover, families and communities play a crucial role. In some conservative regions, technology is seen as a threat to traditional educational values. According to Black and Wiliam (2009), teachers and students tend to value direct human interactions, which sometimes hinders the adoption of digital tools [19]. Thus, to maximize the effectiveness of technologies, an approach adapted to local cultural and social contexts is necessary [24].

5. CONCLUSIONS

The findings of this study clearly indicate that digital tools should take precedence over traditional paper-and-pencil methods in the formative assessment of students. Digital technologies not only provide immediate feedback but also enable teachers to quickly assess students' achievements, which is crucial for effectively adjusting instruction. For students, these digital tools facilitate self-assessment, encourage reflection, and strengthen active engagement in learning, allowing them to better understand their own progress and become more aware of their strengths and weaknesses.

In this article, we have sought to demonstrate that the use of digital tools in formative assessment has a significant impact on learners' achievements, thanks to the ease and variety of feedback, in contrast to traditional formative assessment. The adoption of these digital methods contributes to the improvement of teachers' assessment practices in the context of modern education, particularly in environments where access to interactive and adaptive tools can enrich the learning experience. Indeed, the integration of digital formative assessment into evaluative pedagogical practices will not only enhance teachers' assessment methods but also support students' acquisition of 21st-century skills. However, it remains necessary to conduct in-depth comparative studies to identify the digital tools that best meet the specific needs of students and teachers in the Moroccan context.

Finally, the results of this study significantly highlight the positive impact of digital technologies on formative assessment, offering innovative perspectives for improving educational practices. By enabling instant feedback, increased personalization of learning paths, and greater student autonomy, digital tools transform assessment into a true learning lever. These advances are not merely technical improvements but represent a fundamental shift in how teaching and learning occur, particularly in the Moroccan context where challenges related to equity and access to resources are significant. Adopting and integrating these technologies on a large scale could not only enhance academic performance but also make education more inclusive and better suited to the diverse needs of learners. This calls for an urgent mobilization of educational policymakers to mainstream these practices, ensuring that students are effectively prepared for the demands of the 21st century.

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BIOGRAPHIES

Name: **Nadir**
Surname: **Zaibout**
Birthday: 16.08.1988
Birthplace: M'diq, Morocco
Bachelor: Web Development, Department of Mathematics, Computer Science and Physical Sciences, Higher Normal School, Abdelmalek Essaadi University, Tetouan, Morocco, 2011
Master: Multimedia Pedagogical Engineering, Department of Computer Sciences and University Pedagogical Engineering, Abdelmalek Essaadi University, Tetouan, Morocco, 2013
Doctorate: Student, Interdisciplinary Laboratory of Research in Pedagogical Engineering, Higher Normal School, Abdelmalek Essaadi University, Tetouan, Morocco, Since Year 2020
Research Interests: Engineering Pedagogy and Didactics of Sciences, Educational Technology, eLearning, Computer Science, Artificial Intelligence, Virtual Reality

Name: **Mourad**
Surname: **Madrane**
Birthday: 16.08.1959
Birthplace: Oujda, Morocco
Bachelor: Biology-Geology, Higher Normal School, Rabat, Morocco, 1983
Master: Pedagogy of Science, Higher Normal School, Rabat, Morocco, 1996
Doctorate: Didactics of Natural Sciences, Faculty of Sciences, Abdelmalek Essaadi University, Tetouan, Morocco, 2016
The Last Scientific Position: Prof., Department of Education, Abdelmalek Essaadi University, Higher Normal School, Tetouan, Morocco, Since 1993
Research Interests: Educational Technology, Educational Engineering, Didactics of Natural Sciences

Name: **Lamiae**
Surname: **Khamlichi**
Birthday: 01.09.1968
Birthplace: Tetouan, Morocco
Bachelor: General Biology, Faculty of Sciences, Sidi Mohammed Ben Abdellah University, Fes, Morocco, 1992
Master: Immunology, Faculty of Sciences, Sidi Mohammed Ben Abdellah University, Fes, Morocco, 1993
Doctorate: Environmental Microbiology, Environmental Microbiology Laboratory, Faculty of Sciences, Sidi Mohammed Ben Abdellah University, Fes, Morocco, 1997 - Postgraduate Doctorate, Microbiology, 2000
The Last Scientific Position: Administrator, Regional Academy of Education and Training, Tetouan, Morocco, Since 2005
Research Interests: Educational Engineering, Educational Technology, Natural Sciences, Administrative Management, International Cooperation, Project Management

Name: **Mohamed**
Surname: **Laafou**
Birthday: 28.03.1958
Birthplace: Kasba Tadla, Morocco
Bachelor: Education Sciences, Higher Normal School, Mohammed V University, Rabat, Morocco, 1985
Master: Educational Technology, Faculty of Educational Sciences, Laval University, Quebec, Canada, 1993
Doctorate: Didactics of Professional Training, Faculty of Educational Sciences, Laval University, Quebec, Canada, 2001
The Last Scientific Position: Prof., Abdelmalek Essaadi University, Department of Education, Ecole Normale Superior, Tetouan, Morocco, Since 2001
Research Interests: Educational Technology, Educational Engineering, Distance Education