

Educational diagnostic testing: A historical overview, its significance, and testing procedures

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Abstract

Educational diagnostic testing supports modern education by identifying learning difficulties, assessing cognitive strengths, and guiding instruction. We searched Google Scholar, Web of Science, and MEDLINE using relevant keywords. This review traces diagnostic testing from Alfred Binet and Théodore Simon's early 20th-century work to its expanded use in contemporary schools, where nearly 70% of U.S. schools employ diagnostic assessments. We clarify core concepts, outline professional competencies needed to design, administer, and interpret diagnostic measures, and summarize current practices and applications. The paper differentiates high-stakes from low-stakes testing, describes common procedures for conducting diagnostic assessments, and synthesizes evidence linking diagnostic approaches to improved student performance. We also examine legal and ethical issues, including GDPR compliance when deploying digital systems such as DQUEST in Europe. Finally, we propose future directions to strengthen validity, fairness, and usability, enabling more personalized learning and equitable access to educational opportunities.

Keywords: Diagnostic testing, testing procedure, testing professionals, significance, testing experience.

Introduction

Educational diagnostic testing has become a pivotal element in educational assessment, aiming to identify and address learning difficulties, measure cognitive abilities, and inform instructional practices. Educational diagnostic testing has evolved significantly since the early 20th century, beginning with Binet and Simon's intelligence test aimed at identifying children needing support (Binet, 1905; Cherry, 2023). Over the decades, testing practices became more structured, driven by developments in psychometrics, behaviorism, and humanistic psychology (Arengo-Jones, 2019; Krikorian, 2024). Tools like the Wechsler Intelligence Scale for Children in the 1960s enabled more precise identification of learning disabilities (Andrikopoulos, 2021). The implementation of laws such as IDEA further emphasized equity in diagnosing learning needs. Since the 2010s, technology has played a central role, with adaptive assessments and data-driven models like RTI and MTSS improving responsiveness to students' needs (Fuchs & Fuchs, 2006; Zhai & Wiebe, 2023). Today, diagnostic testing adopts a more holistic and inclusive approach, integrating cognitive, emotional, and cultural factors to support diverse learners (Hargreaves & Shirley, 2012; Linn, 2020). Through diagnostic assessments, educators gain a deeper understanding of the strengths and weaknesses of individual learners, helping to tailor instructional strategies to promote better outcomes (Bennett, 2018; Esomonu & Eleje, 2020).

Diagnostic testing is a specialized form of assessment aimed at identifying specific learning needs or challenges that students may face in their educational journey. Unlike

summative or formative assessments, which evaluate overall achievement or progress, diagnostic testing aids to provide a detailed analysis of a learner's strengths and weaknesses in particular areas of knowledge or skills. They are designed to pinpoint the root causes of difficulties, enabling targeted intervention (McMillan, 2017 Cruz et al., 2024; Sun & Suzuki, 2013). In educational settings, diagnostic testing according to Esomonu and Eleje (2020) is integral to addressing individual learning gaps, often through standardized or customized tests that offer immediate feedback on specific learning outcomes. One example of diagnostic testing practices includes the use of reading fluency assessments, which track a student's ability to read text accurately and quickly, helping educators identify areas where additional support might be needed, such as phonemic awareness or vocabulary. Similarly, testing of math diagnostic tools can be used to identify misconceptions in arithmetic or algebra, providing detailed results that guide instructional strategies.

In recent decades, the application of diagnostic testing has expanded significantly. According to a 2022 survey by the National Center for Education Statistics (NCES), approximately 70% of U.S. schools employ some form of diagnostic testing to identify students with learning disabilities and to tailor interventions (National Center for Education Statistics [NCES], 2022). This widespread use reflects the growing emphasis on individualized education plans (IEPs) and the need for data-driven decision-making in educational settings. Diagnostic test testing has evolved to incorporate a broader range process of educational and psychological constructs, including specific learning disabilities and socio-emotional factors. Additionally, the integration of computer-based tools and data analytics has enabled educators to conduct more precise and frequent assessments, thereby improving the accuracy and effectiveness of educational interventions (Zhai & Wiebe, 2023).

Statistical data also highlight the impact of diagnostic testing on student outcomes. There are indications that schools utilizing diagnostic testing report a 15% higher rate of improved student performance compared to those that do not (Fuchs & Fuchs, 2006). Furthermore, a longitudinal study by the Institute of Education Sciences found that students who receive targeted interventions based on diagnostic assessments show significant gains in academic achievement, particularly in reading and mathematics (Institute of Education Sciences, 2021).

These findings underscore the importance of diagnostic testing in identifying learning challenges early and implementing effective strategies to enhance educational outcomes.

This paper discusses the concept of educational diagnostic testing and explores the essential skills required for professionals working in this field. It examines innovations in diagnostic testing practices and differentiates between high-stakes and low-stakes testing within the diagnostic context. The paper also delves into the procedures involved in conducting diagnostic assessments, offering a detailed overview of methodologies and implementation strategies. Finally, it concludes, and offers the challenges faced in educational diagnostic testing and outlines potential future directions for research and practice in this evolving area.

Methods

A literature search was conducted in January 2025 to identify relevant publications and updates on educational diagnostic testing. Search terms included educational diagnostic testing, learning difficulties assessment, adaptive educational testing, student data privacy, testing validity, and instructional decision-making. The following databases were used: Google Scholar, Web of Science, and MEDLINE. The search strategy focused on identifying materials related to both the effectiveness and the challenges of diagnostic assessments, with particular attention to data security, implementation procedures, and educational impact.

Concept of the Educational Diagnostic Testing

Educational diagnostic testing involves the administration of diagnostic test, scoring and interpretation of the diagnostic test result data. It is an assessment process designed to identify a student's specific learning needs or difficulties. The intention is to provide a detailed analysis of a student's academic abilities/skills, highlighting strengths, weaknesses, and pinpoints specific learning point of a skill that requires improvement (Black, 2024; Esomonu & Eleje, 2020). This personalized insight serves as a guide to support the student's educational progress.

Educational diagnostic testing according to Eleje et.al (2020), allow educators and parents to customize teaching strategies to address individual learning gaps through remediation, promoting overall academic development. The approach behind diagnostic testing or assessments involves an in-depth evaluation of a student's performance on specific skills and concepts, that is the skills underlying the tests' construct. In contrast to summative assessments,

which evaluate knowledge at the conclusion of a lesson or unit, diagnostic assessments are ongoing and formative (Mjenda, 2023). But diagnostic assessment or testing help to identify specific learning points where a student is struggling and provide clarity on the nature of these difficulties (Matthews, 2024). Diagnostic testing focuses on pinpointing areas where students may require additional support or intervention. By conducting diagnostic testing on students' learning needs early, educators can tailor instruction to meet individual learning styles and pace, ultimately enhancing educational outcomes (Bennet, 2018). Diagnostic testing processes are designed not only to evaluate what students have learned but also to diagnose areas where they may require additional support or enrichment.

Thus, diagnostic tests are often designed to aid the diagnostic test testing professionals to provide educators with valuable insights into students' cognitive skills, academic achievements, and potential learning difficulties (Esomonu & Eleje, 2017). The diagnostic quantitative economics skill test for Secondary Schools developed by Esomonu and Eleje (2017) has these features. The comprehensive understanding of the effective administration of diagnostic tests is fundamental for educators and educational researchers alike, as it directly impacts instructional planning and student outcomes. The testing procedures associated with diagnostic tests are crucial as they determine the validity, reliability, and fairness of the results, thereby influencing instructional decisions and student outcomes.

Uses of diagnostic testing: The application of diagnostic testing to the student enables the teacher to determine the nature and cause of a student's learning weakness, with the main purpose of correcting and remedying the difficulty. It helps the teacher diagnose and identify specific problems each student has in studying a subject (Roediger et al., 2011). The goal of diagnostic assessments is to identify specific areas within a subject where a student struggles or where errors frequently occur. These assessments are more beneficial when conducted multiple times throughout the school year by the teacher. According to Delgado (2019), while some authors suggest that diagnostic evaluation should be applied at the start of a topic or academic period and integrated into regular practice with ongoing feedback, doing so at various points in the year offers distinct advantages (Delgado, 2019).

Esomonu and Eleje (2020) outline several key benefits of diagnostic testing outcome.

1. They help identify which items, units, or skills are not understood by most students, allowing for targeted focus on these areas.

2. They reveal the underlying causes of difficulties with specific items, enabling the implementation of remedial measures.
3. They identify individual weaknesses, providing a basis for personalized corrective work and guidance.
4. They can be used for prognostic purposes, predicting potential success in certain courses or careers, and assisting with guidance and counseling.
5. They can support individualized instruction by informing differentiated teaching methods, ability grouping, and tailored assignments.
6. They measure "real understanding" rather than superficial knowledge, as reflected in students' achievements in specific subject areas.
7. They help students identify their weaknesses, making it easier and more efficient to address them.
8. They can assess the effectiveness of specific teaching methods for particular educational situations.
9. They can foster student motivation and interest, and encourage cooperation in future teaching and learning scenarios.

The primary purpose of diagnostic testing is twofold: first, to diagnose individual student needs comprehensively and second, to inform targeted instructional strategies tailored to meet those needs (Farhady & Selcuk, 2022). This diagnostic approach not only supports personalized learning but also facilitates early intervention, potentially preventing academic difficulties from escalating (Benton, 2018).

Diagnostic testing data is not meant to categorize students but rather to enhance their learning experience and improve their achievement. Unlike assessments that predict future performance, diagnostic assessments focus on evaluating what students already know and identifying potential difficulties that could hinder their engagement with new material. These assessments are typically administered before instruction begins or when specific issues emerge (Esomonu & Eleje, 2017). Consequently, diagnostic tests offer a comprehensive overview of students' strengths and weaknesses in their learning areas.

Essential Skills for Testing Professionals

Professionals involved in diagnostic testing must possess a variety of skills to ensure the tests are properly administered, interpreted, and applied to improve student academic outcomes (Esomonu & Eleje, 2020). These professionals require specialized expertise in both test administration and result interpretation. According to the Committee on Psychological Testing, Including Validity Testing, for Social Security Administration Disability Determinations, Board on the Health of Select Populations, and Institute of Medicine (2015), experts in this field must be proficient in selecting appropriate tests, creating testing conditions that ensure accurate results, and interpreting data in a way that informs instructional practices. Additionally, they must collaborate with other educators to apply results that meet individual student needs. The ability to clearly communicate findings to students, parents, and school administrators is also essential (Harris, 2020). Researchers such as Zhai and Wiebe (2023) and Fuchs and Fuchs (2006) emphasize that these skills require a deep understanding of psychometrics, ethical considerations, and the capacity to interpret diagnostic test data effectively to support individualized instructional strategies.

Knowledge of psychometrics: One of the most important skills for educational evaluators is a solid understanding of psychometrics, the science behind test design, development, and evaluation. Psychometrics involves the measurement of cognitive and psychological variables, and test developers must be familiar with key concepts such as reliability, validity, and standardization (Cherry, 2023). Hence, when administering a diagnostic test, professionals need to ensure that the test is reliable, that is, it produces consistent results across different settings and times, and valid that is, it accurately measures what it is intended to measure.

Testing professionals must also understand the importance of item analysis in diagnostic assessments. Item analysis involves examining how individual questions on a test perform with different groups of students to determine their relevance, difficulty level, and ability to discriminate between students with different levels of ability (Eleje et al., 2016; Ugodulunwa et al., 2022). By analyzing item responses, Popham (2017) noted that professionals can identify any biases or flaws in the test, ensuring that it accurately assesses students' knowledge and skills.

Ethical considerations: Ethical concerns apply broadly across assessment types, not only diagnostic testing. Thus, ethical considerations are paramount when administering and interpreting diagnostic tests link in other test. Testing professionals must adhere to ethical

guidelines to protect students' privacy, ensure fairness, and avoid harm. For example, one key ethical issue is the confidentiality of diagnostic test results. The diagnostic test professional must ensure that any personal data or diagnostic test outcomes are securely stored and only shared with authorized personnel, in line with data privacy regulations such as the Family Educational Rights and Privacy Act (FERPA) in the United States (Fuchs & Fuchs, 2006).

Furthermore, diagnostic testing professionals must be aware of the potential for bias in diagnostic tests. Cultural, linguistic, and socioeconomic biases can affect the accuracy of assessments, particularly for students from diverse backgrounds. They should use culturally responsive tests or adjust assessments to minimize these biases. Testing professionals should also be mindful of the impact that labeling students based on diagnostic test results may have on their self-esteem and educational experiences.

Interpretation of diagnostic test data: The ability to interpret diagnostic test results effectively is another essential skill for testing professionals. Diagnostic tests provide valuable data that can guide educators in identifying learning difficulties, measuring cognitive skills, and planning appropriate interventions. However, interpreting these results requires more than just looking at raw scores. As described by the Institute of Education Sciences (2021), professionals must be able to contextualize the data, considering factors such as the student's background, prior knowledge, and the instructional setting.

For example, a student who performs poorly on a diagnostic test may have difficulties with specific cognitive processes, such as attention or memory. However, the test results alone cannot provide a full picture of the student's challenges. Testing professionals must use their knowledge of the individual student and educational theory to identify the root causes of the student's difficulties. This involves analyzing patterns in test results and comparing them with other assessment data, such as classroom observations and teacher reports (Institute of Education Sciences, 2021).

Moreover, professionals must be able to translate diagnostic test results into actionable instructional strategies. For instance, if a diagnostic test reveals that a student is struggling with reading comprehension, the professional may recommend targeted interventions, such as focused reading instruction, vocabulary development, or strategies to improve reading fluency. These recommendations according to Fuchs and Fuchs (2006) should be individualized based on the

student's specific needs, ensuring that the interventions are tailored to the student's learning style and challenges. Important factor in interpretation of diagnostic test data is benchmarking.

Benchmarking in educational diagnostic testing: Benchmarking plays a crucial role in ensuring the accuracy, reliability, and relevance of the results. Two key approaches to benchmarking are normative and criterion-referenced benchmarks. Normative benchmarking compares the performance of individuals or groups against a larger, representative sample, while criterion-referenced benchmarking evaluates performance based on predefined standards or learning outcomes (Nitko & Brookhart, 2013). Both methods are valuable, depending on the purpose of the diagnostic test and what is being measured. For instance, a normative benchmark might compare a student's performance to peers in a national or regional sample, while a criterion-referenced benchmark might assess whether the student has met specific learning goals or competencies.

The system developed in Hungary and used nationally provides a strong example of how benchmarks can be applied in diagnostic testing. In Hungary, the system allows for the comparison of students' performance to both normative standards (such as national averages) and specific learning criteria, offering a dual approach to benchmarking that ensures comprehensive assessment (Molnar et al., 2020). This combined method allows educators to better understand where a student stands not only in comparison to peers but also in relation to established academic goals.

It is important to note that, regardless of the mode of test delivery, professional skills remain essential, whether in administering tests or in developing and interpreting automated systems (Zhai & Wiebe, 2023; Fuchs & Fuchs, 2006). Online systems may simplify data collection, but diagnostic expertise is still needed to ensure validity, interpret results, and make instructional decisions.

Innovations in Diagnostic Testing Practices

Recent innovations in educational diagnostic testing have increased the role of technology in the administration and interpretation of assessments. Computer-based diagnostic tests, for example, offer the advantage of providing more standardized and efficient testing environments. These tests can adapt to the student's responses, providing a personalized assessment that better captures their abilities. Additionally, advancements in item banks allow

for more flexible testing that can be tailored to each student's level of proficiency, further supporting individualized learning (Bennett, 2018). Moreover, the integration of artificial intelligence and machine learning in diagnostic testing systems is helping to enhance the precision and efficiency of assessments. These technologies can analyze large datasets to identify patterns and predict students' learning needs, enabling more proactive interventions. However, diagnostic testing professionals must be equipped with the skills to use these technologies appropriately, ensuring that the data is interpreted correctly and that the technology is used to complement, not replace, their professional expertise (Zhai & Wiebe, 2023). But, technological tools enhance diagnostic capabilities but are not exclusive to diagnostic tests.

Significant advancement in educational diagnostic testing (The eDia System): The eDia system, developed in Europe, represents a significant advancement in the field of educational diagnostic testing. This online platform offers teachers and students personalized diagnostic assessments, providing essential feedback that supports individualized learning. Developed as a part of the EU-funded project, the eDia system was designed to assess a wide range of subjects and learning outcomes, allowing educators to identify the strengths and weaknesses of their students with greater precision. In turn, this enables more effective tailoring of teaching methods to better address the unique needs of each learner. The system aims to improve the quality of education by offering reliable diagnostic data that supports differentiated instruction, making it a vital tool in modern education (Csapo & Molnar, 2019). As research has shown, diagnostic tools like eDia have the potential to greatly improve teaching strategies and enhance student outcomes by providing timely and accurate data (Bennett, 2018; Ding et al., 2024).

In Europe, the shift toward online diagnostic testing has been marked by significant developments, including the widespread adoption of systems like eDia. These tools enable educators to implement assessments that are crucial in monitoring student progress and adjusting instruction as needed (Jönsson & Svingby, 2007). The growing use of digital diagnostic platforms aligns with the increasing demand for data-driven decision-making in education. Moreover, the integration of technologies such as artificial intelligence (AI) in these systems is further advancing their capacity to provide personalized and real-time feedback. This trend according to Lim et al. (2024) is evident in other European initiatives as well, which aim to incorporate technology into educational assessment to promote better learning experiences.

The importance of the eDia system lies in its ability to support personalized education, an approach that has gained significant attention in recent years (Csapo & Molnar, 2019). By offering detailed diagnostic information about individual students, the system allows educators to create customized learning paths that suit each learner's needs. This personalized approach has been shown to improve student engagement and achievement (Black & Wiliam, 2018). In addition to the eDia system, other European innovations in diagnostic assessment, such as adaptive learning technologies and AI-driven platforms, are contributing to the growing body of research on personalized education. These systems not only enhance teaching practices but also empower students by providing them with the resources to take control of their learning journey.

As diagnostic assessment tools like eDia continue to develop and become more widespread, they hold the potential to influence educational practices globally. The European advancements in online diagnostic assessments are paving the way for broader applications of personalized learning methods, with the aim of improving educational outcomes for students worldwide. These innovations mark an exciting shift towards data-informed, individualized teaching that could shape the future of education in world.

Item banks and computer-based assessment (CBA): Item banks and computer-based assessment (CBA) have become essential components in the development and implementation of diagnostic testing. Their integration into educational assessment has enhanced the accuracy, reliability, and flexibility of evaluating student performance. Item banks, which are collections of test items, allow for the creation of adaptive assessments that can cater to individual student needs (Mohd Noh & Mohd Matore, 2019). By using a wide range of items, these banks make it possible to generate customized tests that measure a student's knowledge more precisely, taking into account their strengths and weaknesses.

The ability to use item banks in diagnostic testing enables the creation of assessments that are both flexible and adaptive. Adaptive testing adjusts the difficulty of questions based on a student's responses, ensuring that the assessment remains appropriately challenging (Burr et al, 2023). This personalized approach not only helps in accurately identifying areas of weakness but also provides a more equitable testing experience for students with different levels of ability (Glas, 2008; Psico-smart Editorial Team, 2024). Furthermore, item banks can be regularly updated, ensuring that tests remain relevant and reflective of current academic standards.

Computer-based assessment or Computer-based testing has further amplified the benefits of item banks by providing a more standardized and controlled testing environment. CBA reduces human error in scoring and allows for quicker feedback, which is crucial in diagnostic assessments (Schär, & Hofer, 2007). In addition, the use of technology allows for the administration of more complex question types, such as simulations or multimedia tasks, which can offer deeper insights into a student's understanding (Eleje et al., 2022; Retnawati et al., 2024). The speed and efficiency of CBA also make it possible to implement large-scale diagnostic assessments, providing valuable data for educators and administrators.

Moreover, CBA offers the flexibility to implement item response theory (IRT), which improves the precision of measuring student abilities. IRT models can analyze the difficulty and discrimination properties of items in real time, making it possible to more accurately estimate a student's performance based on their responses (Baker, 2001; Esomonu & Eleje, 2017). This capability according to Eleje et al. (2018) enhances the validity and reliability of diagnostic tests by ensuring that the scores reflect the true abilities of students, rather than being influenced by test format or administration conditions.

In summary, item banks and computer-based testing are essential tools in the development of effective diagnostic assessments. They provide a means to create flexible, adaptive tests that cater to individual learning needs while maintaining standardized, accurate, and reliable measurement. The integration of item banks with CBA ensures that diagnostic tests are not only more efficient but also offer a higher level of validity and precision, significantly improving the educational diagnostic process.

High-Stakes and Low-Stakes Testing in Diagnostic Testing

Low-stakes and high-stakes testing is a critical issue when considering the use of diagnostic assessments in education (Pools & Monseur, 2021).). The very essence of diagnostic testing is that it is low-stakes and helps the learning process and not a test of the student's future, because of the stakes involved, the way these tests are used and interpreted can differ greatly, influencing educational interventions and student experiences. The importance of distinguishing between low-stakes and high-stakes testing lies in how they shape teaching and learning processes. Understanding the implications of low-stakes versus high-stakes testing is essential for determining how diagnostic assessments should be implemented in education.

Table 1
High-Stakes vs. Low-Stakes Testing in the Diagnostic Context

Aspect	Low-Stakes Testing	High-Stakes Testing
Purpose	Provide feedback to students and teachers without significant consequences for the learner's academic record (Cole & Osterlind, 2008).	Tied to major outcomes such as grade advancement, graduation, or school funding.
Use in Education	Identify areas of improvement and guide instructional decisions.	Measure educational standards and ensure accountability.
Impact on Students	Encourages a growth mindset, allowing for mistakes and improvements without the pressure of consequences (Bennett, 2018).	Can create stress and pressure, potentially leading to negative effects on self-esteem and future educational opportunities for students.
Impact on Teaching	Supports a more individualized approach, allowing teachers to tailor instruction based on students' specific needs.	Can lead to "teaching to the test," where the curriculum narrows to focus on test preparation, possibly neglecting other important areas of learning.
Feedback Frequency	Allows for ongoing, formative feedback to track progress over time (Black & Wiliam, 2018).	Typically used as a summative assessment with fewer opportunities for ongoing feedback.
Effect on Curriculum	Encourages flexible teaching methods and exploration of a broad curriculum to meet individual student needs.	May result in curriculum narrowing, focusing primarily on test content and preparation.
Consequences for Failure	Generally, no significant long-term consequences for the student.	Can have serious consequences, including affecting future educational opportunities and academic progress.
Effectiveness in Guiding Interventions	More effective for guiding personalized interventions, as it allows educators to focus on specific student needs.	May limit the ability to guide personalized interventions due to its focus on standardized outcomes (Ding et al., 2024).
Overall Educational Impact	Promotes an environment where students can progress based on their learning, without fear of failure affecting their academic record.	Can create a high-pressure environment that may hinder true learning and the ability to address diverse student needs (Jönsson & Svingby, 2007).

This comparison highlights the contrasting roles that low-stakes and high-stakes testing play in education and how they impact students, teachers, and educational outcomes.

Procedures of Diagnostic Assessment/Testing

Diagnostic assessment entails a process adopted to locate and identify students' specific areas of learning difficulties in a learning skill of a subject. It implies a detailed study of learning weaknesses in a particular skill. Diagnostic testing can be effectively administered through various modes, including face-to-face interactions, paper-based formats, and online platforms, without compromising its effectiveness. The choice of delivery method does not inherently impact the validity or utility of the test results; rather, it is the diagnostic features, such as the test's purpose and how the results are used, that determine its value and relevance. As noted by Esomonu and Eleje (2020) and Smith and Jones (2019), the medium of delivery plays a secondary role to the underlying objectives and interpretation of the assessment outcomes. The diagnostic assessment process need to be linked to further work (remediation) which will tackle problems identified (Esomonu & Eleje, 2020). The testing procedures associated with educational diagnostic tests encompass a series of standardized practices aimed at ensuring the reliability, validity, and fairness of assessment outcomes (AERA, 2020). These procedures typically include:

1. **Test Development:** The process of test development involves careful consideration of educational objectives, alignment with curriculum standards, and validation through rigorous research methodologies. Diagnostic tests must be designed to accurately measure the intended skill constructs and provide reliable insights into students' learning profiles. For sample of diagnostic test and a detail description of diagnostic test development stages, see Esomonu and Eleje (2017).

2. **Administration Procedures:** Proper administration procedures are essential to maintain consistency and fairness across all test-takers. This includes preparing the diagnostic testing administration schedule, then the test administration/execution and the testing experience (Esomonu & Eleje, 2020). Also, necessary is creating a conducive testing environment, providing clear instructions, and ensuring that all students have equal opportunities to demonstrate their knowledge and skills.

The testing schedule: The testing schedule according to (AERA, 2020; Esomonu & Eleje, 2020) typically includes the following information:

- i. Test Data: The data the test is scheduled to take place.
- ii. Test Time: The time the test is scheduled to start and end.
- iii. Test Type: The type of test being administered (e.g., multiple-choice, essay, practical).
- iv. Test Duration: The length of time allocated to the test.
- v. Test Location: The venue where the test will take place.
- vi. The Test Format: The format of the test (e.g., online, paper-based, oral).
- vii. Test materials: Any materials required for the test (e.g., calculators, pens, ID).
- viii. Test Instructions: Any specific instructions or rules for the test.

In Table 2, using the Diagnostic Quantitative Economics Skill Test (DQUEST) developed by Esomonu and Eleje (2017) the researchers writes a sample of a diagnostic testing administration schedule. Then the testing procedure and the testing experience. The researchers divided the DQUEST into four sections for easy administration. Thus DQUEST administration is done in four sessions. This diagnostic testing treatment administration schedule and procedure is assumed to be done during the normal class periods. A period will last for 40 minutes.

Table 2
Diagnostic Quantitative Economics Skill Test Testing Schedule

Test Date:	To be decided by the test administrator.
Test Time:	To be decided by the test administrator.
Type:	Multiple choice items.
Duration:	Four sessions, each of which lasted for 40 minutes.
Location:	SSS III class rooms of the three experimental groups
Format:	Paper-based test
Recipients:	SSS III economics students in the three experimental groups from 3 public co-education schools in Nnewi Education Zone of Anambra State.

Instruments/Materials: Diagnostic Quantitative Economics Skill Test (DQUEST) by Esomonu and Eleje (2017), pencil, plane sheet and calculator.

DQUEST Sub-Skills: Calculate, use and understand/interpret ratios, fractions, percentages, percentage changes, mean, median, relevant quartiles, graphical forms, index numbers, cost, revenue, profit, elasticity and calculation to convert from money to real terms.

Objectives: The goal of this treatment is to identify the students' who need help in quantitative economics and to locate their areas of strengths/weaknesses.

Instruction: Attempt all items.

Source: Authors' own development.

Test administration/execution: Test administration, or test execution, is the process of carrying out the test according to the established procedures and guidelines (Esomonu & Eleje, 2020). This phase ensures that the test is executed consistently, fairly, and accurately while maintaining a controlled environment for the test-takers or systems being evaluated. The main goal is to observe, monitor, and manage the test process to collect reliable data and achieve the intended assessment outcomes (Education Advanced, 2023). Below are the key steps involved in the test administration/execution phase.

- **Test Distribution:** Administrators distribute the test materials to participants, which may include printed exam papers or access to an online testing platform.
- **Monitoring and Supervision:** Test-takers must be supervised to ensure compliance with the rules and prevent cheating. This could involve watching students in a classroom or monitoring the execution of automated tests in software testing (Education Advanced, 2023). Administrators observe participants to make sure they follow the rules and stay focused, which can include walking around in educational settings or tracking test executions in digital environments.
- **Time Management:** Administrators ensure the test is completed within the designated time by keeping track of time and providing time warnings. They also manage breaks and ensure that the test is finished within the scheduled period (Sireci & Botha, 2020).
- **Assistance and Troubleshooting:** Administrators are available to assist participants with any instructions or technical difficulties that arise during the test. They address any issues related to test content or technical problems during digital testing and are prepared to handle technical failures, such as system crashes.

- **Test Environment Preparation:** Before the test, the testing environment, whether physical or virtual, is set up to ensure all equipment and systems are ready and operational.
- **Test Materials and Resources:** Administrators ensure that all necessary materials, such as printed papers or digital platforms, are prepared and functioning correctly.
- **Clear Instructions and Orientation:** Administrators give participants clear and detailed instructions about the test, including the test duration, rules, permitted resources, and any accommodations. For more complex or new tests, administrators may conduct a briefing to familiarize participants with the format and procedures (Esomnu & Eleje, 2020).
- **Test Security:** Administrators take measures to ensure the test's integrity by verifying the identity of participants, watching for suspicious behaviors, and implementing security protocols for digital tests.
- **Test Consistency:** Administrators ensure uniform test conditions for all participants to maintain fairness and avoid any potential bias.
- **Addressing Test-Taker Issues:** Administrators help participants with any difficulties they experience, such as stress or confusion, while making sure they adhere to the rules.
- **Test Completion:** After the test, administrators collect physical materials or confirm the successful submission of digital tests, ensuring all data is logged for later analysis.
- **Documentation and Logging:** Administrators document any issues or irregularities, such as technical problems or cheating incidents that could impact the test results' validity.

Testing experience: The testing experience refers to the tester's perception and the challenges faced during the testing process (Ekwoje et al., 2017). It can vary depending on the complexity of the system being tested, the resources available, and the tools employed. Key aspects of the testing experience include:

1. **Challenges in Communication:** One of the common challenges testers face is effective communication with the development team. Misunderstandings regarding requirements or unclear specifications can lead to testing inefficiencies. Clear communication channels help in resolving these issues and ensure that both teams are aligned on testing goals.
2. **Dealing with Complex Systems:** Testing complex systems or software applications can be overwhelming, particularly when the system's design is not fully understood. In such cases, exploratory testing techniques, where testers use their intuition and experience to uncover hidden issues, can be very useful.

3. **Time Constraints:** Testers often work under tight deadlines, which can impact the depth and thoroughness of testing (Sireci & Botha, 2020). Rushed testing increases the risk of missing defects, potentially leading to post-release issues. Proper planning and realistic scheduling are crucial to overcoming time limitations.
4. **Automated Testing:** The rise of automation has improved the testing experience, particularly in large-scale or repetitive tasks. Automation allows for faster execution of tests, quick feedback on code changes, and easier regression testing. However, setting up automated tests requires significant upfront effort and expertise.
5. **Learning and Adaptation:** Each testing experience presents learning opportunities, such as mastering new tools, techniques, or handling specific types of tests like performance or security testing (Eleje et al., 2024). Testers often adapt to the product, team, and tools, evolving their skill set to handle diverse testing scenarios effectively.

Depending on the grade level, the test administrator may read parts of the assessment to the students, manage the timing, and record their responses during the test. Overall, the testing experience is shaped by the individual's ability to problem-solve, communicate effectively, and adapt to changing project requirements (Esomonu & Eleje, 2020).

The diagnostic test administration/execution: Below is the DQUEST test administration/execution prepared by the researchers, using the schedule in Table 2.

Session 1: Administration of Section 1 of the Diagnostic Quantitative Economics Skill Test (DQUEST) on the students.

Objectives of the Session

To successfully administer diagnostic test which assesses skill in calculation, use and understanding of ratios, fractions, mean, median and relevant quartiles while emphasizing its role in assisting students improve their quantitative skill in economics.

Session 2: Administration of section 2 of the DQUEST test on the students.

Objectives of the Session

To be able to administer diagnostic test which assess strengths/ weaknesses in calculation, use and understanding of percentage, percentage changes, elasticity and interpretation of the result.

Session 3: Administration of section 3 of the DQUEST on the students.

Objectives of the Session

To carry out a diagnosis testing that ascertains students' skill in interpreting/analyzing range of standard graphical and numerical forms.

Session 4: Administer section 4 of the DQUEST on the students.

Objectives of the Session

The aim of this session is to conduct diagnostic testing on students' skill to calculate and interpret index numbers, cost, revenue, profit and to convert money to real terms.

The diagnostic testing experience: Below is the DQUEST testing experience using the schedule in Table 2.

- Firstly, the test administrator (class teacher, researcher, etc.) tried to win the confidence of the students and reassure them that the test is to help them in the improvement of their learning of quantitative economics rather than for declaring pass or fail.
- Teacher ensured a relaxed environment by requesting the students to sit comfortably on their chairs in the class and cooperate with the testing process.
- Students were asked not to consult each other while taking the test.
- Students were allowed to seek clarification on ambiguous issues from the teacher.
- The teacher ensured that the students taking the test attempt all questions. Time schedule were not enforced strictly. Students that take a little more time were allowed to do so.
- In line with Oosterhof (2003), and Esomonu and Eleje (2020), both the question paper and answer script were collected once each student attempts all items or was through.

Observation:

- The teacher observes students' reactions while taking the test and addresses any ambiguity and concerns raised by the students.

Question:

- The students were asked why they want to participate in diagnostic testing process. They were further asked why they would love to improve their quantitative skills in economics.

Closure:

- The teacher thanked students for their dispositions to participate in the diagnostic testing process.

3. **Scoring and Interpretation of Educational Diagnostic Test Testing Results:** Establishing clear scoring rubrics and interpretation guidelines is critical for deriving meaningful insights from test results (Highland Council of Education, Culture and Sport Services, 2010). Educators must understand how to interpret scores, identify learning needs based on performance data, and use this information to inform instructional planning effectively. Interpreting educational diagnostic test results is a multifaceted process that requires a careful blend of statistical analysis and educational insight. The educational diagnostic test testing result can be interpreted using the statistical norm-referencing and criterion-referencing methods.

The statistical norm-referencing method: One commonly employed method is statistical norm-referencing, which compares a student's test performance to that of a normative group, usually representing a larger, well-defined population (Mehrens & Lehmann, 1991). This approach helps educators understand where a student stands relative to their peers, making it easier to identify those who are significantly above or below average. However, norm-referencing has its limitations, including potential cultural biases and the risk of labeling students in ways that may affect their self-esteem and motivation (Lakin & Kell, 2020). Therefore, it is crucial for educators to consider these factors when interpreting results and to use them as one part of a more comprehensive assessment approach.

Criterion-referencing method: Another prevalent method is criterion-referencing, where test results are interpreted based on predefined standards or learning objectives rather than comparisons with peers (Popham, 2018). This method focuses on whether a student has achieved specific competencies or knowledge levels, which can be particularly useful for measuring mastery of particular skills. Criterion-referencing allows for a clearer understanding of what students have learned and where they need further instruction, but it also necessitates that the criteria used are both valid and reliable to ensure fair assessment (Webb, 2002). Educators must ensure that the criteria align closely with educational goals and that they are used consistently across different student assessments.

4. **Feedback and Reporting:** Timely feedback and comprehensive reporting are integral components of effective diagnostic testing procedures. Educators should communicate assessment results to students, parents, and stakeholders in a clear and constructive manner,

emphasizing specific skill areas of strength and opportunities for growth (Benton, 2018). This will lead to remediation and subsequent improvement on students' week learning points.

Concerns with DQUEST and General Data Protection Regulation (GDPR): The use of the DQUEST system in Europe might raise several concerns regarding compliance with the General Data Protection Regulation (GDPR), particularly in relation to the collection of identifiable student data. The GDPR is a regulation designed to protect the privacy and personal data of individuals within the European Union (EU), ensuring that any data collected is processed lawfully, transparently, and for specific purposes (European Union, 2018). In the case of diagnostic testing systems like DQUEST, which may involve sensitive student information, there are strict requirements regarding consent, data storage, and the rights of data subjects. Educational institutions testing professionals must ensure that any identifiable student data is collected and stored in accordance with GDPR principles, such as data minimization, purpose limitation, and secure processing (Kuner, 2017). Failure to comply with these regulations could lead to significant legal and financial consequences, including penalties and loss of public trust.

Consequently, ethical and legal considerations are paramount when implementing diagnostic testing systems like DQUEST. Protecting student privacy and securing their personal data are critical to maintaining the integrity and trustworthiness of the educational system (Bala, 2022). Institutions must obtain explicit consent from students or their guardians, ensuring that individuals are fully informed about the purpose of data collection, the types of data collected, and their rights to access, rectify, and erase their personal information (Voigt & Von dem Bussche, 2017). Additionally, the system should be designed to ensure secure storage and handling of student data, preventing unauthorized access or misuse. By adhering to GDPR requirements and upholding strong ethical standards, educational institutions can safeguard student information and foster confidence in the diagnostic testing process.

Conclusion

Educational diagnostic testing remains an essential tool for identifying learning challenges and informing instructional decisions. Through tailored assessments, educators can provide targeted interventions that address specific areas of difficulty, ultimately improving student performance. As technology continues to advance, diagnostic tools are becoming more precise and accessible, allowing for more frequent and accurate assessments. The widespread use

of diagnostic testing in schools is a testament to its effectiveness in fostering individual student growth. Moving forward, further advancements in testing procedures and the integration of data-driven approaches will continue to enhance the precision and impact of educational diagnostic assessments, contributing to better outcomes for learners across diverse educational settings. Moreover, educational diagnostic testing is vital for assessing students' learning needs and guiding instructional practices. As researchers explore new methods and refine testing techniques, their findings enhance the effectiveness of diagnostic testing, improving both student learning outcomes and educational fairness. A clear understanding of their purpose, appropriate application, and proper administration enables educators to create more inclusive and effective learning environments. Ongoing research and development in diagnostic testing continue to improve these assessments' impact on educational success and equity.

Challenges and Future Directions

Although widely used and beneficial, educational diagnostic testing faces several challenges. One major concern is ensuring the validity and reliability of assessments across diverse student populations. Cultural and linguistic differences can lead to biased results, affecting how accurately the tests reflect students' true abilities. Additionally, the increasing reliance on standardized testing has raised concerns about narrowing instructional focus and placing excessive pressure on students and educators. Another key challenge involves data privacy and security, especially with the use of DQUEST in regions governed by the General Data Protection Regulation (GDPR). Educational institutions must obtain explicit consent for data collection, ensure transparent data use, and provide students with control over their personal information.

Looking ahead, research is focusing on developing testing tools that are fairer and more accurate. Advances in educational technology, including adaptive testing and digital assessment platforms, offer opportunities for more tailored and responsive testing methods. There is also growing interest in integrating diagnostic testing with classroom instruction to better support student learning. Future work will likely aim to align diagnostic tools with educational standards, improve accessibility, and address ethical and legal requirements related to data use. These efforts can help maximize the usefulness of diagnostic assessments and contribute to better outcomes for students in a variety of learning environments.

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