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Formative assessment for students on risk

Introduction

This guide is designed to assist university mathematics educators focused on reducing dropout rates among first-year students. Formative assessment is a powerful tool to identify struggling students early and provide timely support. This guide outlines key principles, strategies, and tools for implementing formative assessment systems in mathematics courses.

1. Formative assessment

Formative assessment refers to ongoing, interactive evaluations that provide feedback to both instructors and students during the learning process. Unlike summative assessments, which evaluate learning at the end of a unit or course, formative assessments aim to improve learning outcomes by identifying gaps and addressing them in real time. Some key characteristics of this alternative type of evaluation are the following:

- Ongoing and iterative: Conducted regularly throughout the course.
- Diagnostic: Identifies strengths and weaknesses in student understanding.
- Feedback-oriented: Provides actionable feedback to students.
- Supportive: Helps students improve without penalizing early mistakes.

A formative assessment requires the design of a process that allows for obtaining precise and detailed information on the degree of development of the expected learning objectives to help make decisions. This information should be sufficient to assign a grade that represents the student's level of learning and motivates them to progress in their education and enrich teaching practices. Therefore, it is essential that students participate in their own assessment and incorporate it as an inherent part of the learning process, which implies a change in the type of instruments and methods to be used.

Thus, Wiliam and Thompson (2007) point out five key elements in formative assessment: (1) clarifying and sharing the purposes of learning and the criteria necessary to achieve the objectives; (2) designing effective learning questions and tasks; (3) providing feedback that moves the student forward; (4) making the student a learning resource for himself; and (5) turning the student into the owner of their own learning.

2. Why is formative assessment beneficial for at-risk students?

Formative assessment plays a pivotal role in addressing the challenges faced by at-risk students, particularly in the context of university-level mathematics. First-year students often encounter significant academic and personal hurdles that can lead to disengagement and, ultimately, dropout. Below, we explore in detail why formative assessment is essential for supporting these students, with a focus on the specific challenges they face and how formative assessment can mitigate these issues.

At-risk students in university mathematics courses often struggle with the following challenges:

1) Transition from high school to university: The shift from high school to university-level mathematics is often abrupt and demanding. High school curricula may not adequately prepare students for the rigor and pace of university courses. And students may lack the foundational knowledge or problem-solving skills required for advanced mathematics, leading to early discouragement.

2) Gaps in foundational knowledge: Many students enter university with varying levels of mathematical proficiency. Those with weaker foundations may quickly fall behind, especially in courses that build on prior knowledge. Then, without early intervention, these gaps can widen, making it difficult for students to catch up.

3) Low confidence and math anxiety: Mathematics is often perceived as a difficult subject, and students who struggle early on may develop math anxiety or a lack of confidence in their abilities. This anxiety can lead to avoidance behaviors, such as skipping classes or not attempting assignments, further exacerbating their difficulties.

4) Limited self-regulation and study skills: University learning requires a high degree of self-discipline and independent study skills, which many first-year students lack. At-risk students may not know how to effectively manage their time, seek help, or engage with course material in a meaningful way.
5) Lack of engagement and motivation: Students who feel overwhelmed or unsupported are more likely to disengage from the course. Without a sense of progress or achievement, their motivation to continue studying mathematics diminishes.

Formative assessment is uniquely positioned to address the challenges faced by at-risk students. Here's how:

- Early identification of struggles: Formative assessments, such as diagnostic quizzes or in-class polls, allow instructors to identify students who are struggling early in the course. By detecting knowledge gaps or misconceptions before they become entrenched, educators can provide targeted support to prevent students from falling behind.
- Building confidence through incremental progress: Formative assessments are typically low-stakes, meaning they do not carry the same pressure as high-stakes exams. By providing opportunities for students to succeed in smaller, manageable tasks, formative assessment helps build their confidence and reinforces a growth mindset.
- Providing timely and actionable feedback: One of the hallmarks of formative assessment is its focus on feedback. Students receive specific, constructive feedback on their performance, helping them understand where they went wrong and how to improve. This feedback loop is critical for at-risk students, who may not have the self-awareness or skills to identify their own weaknesses.
- Encouraging active engagement: Formative assessments often involve interactive and engaging activities, such as group problem-solving, peer reviews, or digital quizzes. These activities break the monotony of traditional lectures and encourage students to actively participate in their learning, which is particularly important for maintaining the interest of at-risk students.

- Fostering a supportive learning environment: Formative assessment emphasizes improvement over grades, creating a less punitive and more supportive learning environment. This approach helps reduce math anxiety and encourages students to view mistakes as opportunities for learning rather than failures.
- Promoting self-regulation and metacognition: Through self-assessment and reflection activities, formative assessment helps students develop metacognitive skills, such as monitoring their own learning and setting goals. These skills are essential for at-risk students, who often lack the self-regulation needed to succeed in university courses.
- Personalizing learning: Formative assessment data allows instructors to tailor their teaching to the needs of individual students. For example, if a formative quiz reveals that a significant portion of the class is struggling with a particular concept, the instructor can revisit the topic or provide additional resources.
- Reducing dropout rates: By addressing academic challenges early and providing ongoing support, formative assessment helps keep at-risk students engaged and motivated. This proactive approach reduces the likelihood of students becoming so discouraged that they consider dropping out.

Research consistently demonstrates the positive impact of formative assessment on student learning, particularly for at-risk populations. A study by Black and Wiliam (1998) found that formative assessment practices can significantly improve student achievement, with the greatest gains observed among low-achieving students. Formative assessment has been shown to reduce achievement gaps by providing targeted support to students who need it most (Hattie, 2009). In the context of mathematics, formative assessment helps students develop a deeper understanding of concepts and improves their problem-solving skills (Nicol & Macfarlane-Dick, 2006).

3. Designing a formative assessment system

Taking in account the five key elements mentioned before, to design a formative assessment system, one can follow the following steps:

1) Set clear learning objectives. Define specific, measurable goals for each topic or module and communicate these objectives to students to align expectations.

2) Use a variety of tools to assess different aspects of learning:

- Diagnostic Quizzes: Assess prior knowledge at the start of a course or module.
- In-Class Polls/Questions: Use tools like Mentimeter or Kahoot to gauge understanding during lectures.
- Problem-Solving Tasks: Assign small, low-stakes problems to practice and assess skills.
- Peer Assessment: Encourage students to review each other's work with clear rubrics.
- Self-Assessment: Have students reflect on their understanding and progress.

3) Constructive feedback:

- Offer specific, actionable feedback that highlights areas for improvement.
- Use a mix of written, verbal, and digital feedback (e.g., comments on assignments, video feedback).
- Encourage students to act on feedback by revising work or seeking help.

4) Monitor progress regularly:

- Track student performance over time to identify trends and at-risk individuals.
- Use learning analytics tools (e.g., LMS dashboards) to visualize progress.

5) Create a supportive environment:

- Normalize mistakes as part of the learning process.
- Offer additional resources (e.g., tutoring, workshops) for struggling students.
- Foster a sense of belonging by encouraging collaboration and peer support.

4. Tools and technologies for formative assessment

Leverage technology to streamline assessment and feedback processes:

- Learning Management Systems (LMS): Use platforms like Moodle, Canvas, or Blackboard to create quizzes, track progress, and provide feedback.
- Online quiz tools: Tools like Google Forms, Socrative, Mentimeter, or Quizizz for quick assessments.
- Interactive whiteboards: Use tools like Jamboard or Miro for collaborative problem-solving.
- Automated feedback systems: Implement AI-based tools (e.g., MapleTA for mathematics) to provide instant feedback on assignments.
- Student response systems: Use clickers or apps like Poll Everywhere to engage students during lectures.

5. Formative assessment for mini-PBL

In the context of a mini-project-based learning (mini-PBL), formative assessment is integrated throughout the project to guide students' learning and ensure they achieve the desired outcomes. Below is a detailed explanation of how formative assessment can be implemented in this context.

The primary goals of formative assessment in a mini-PBL activity are:

- To monitor students' progress in understanding mathematical concepts and their application to real-world problems.
- To provide timely feedback that helps students refine their mathematical models, data analysis, and problem-solving skills.
- To encourage self-reflection and peer collaboration, fostering a deeper understanding of the SDGs and the role of mathematics in addressing them.
- To ensure students effectively use ICT as Desmos as a tool for visualization, modeling, and analysis.

1) Ongoing Feedback

- Instructor Feedback: During each session, the educator circulates among the groups, observing their progress, asking probing questions (open-ended questions to gauge students' understanding and encourage deeper thinking), and providing constructive feedback.

  Example: "Your model is a good start, but have you considered how changing this parameter in Desmos might affect the outcome?"

- Peer Feedback: Facilitate small-group discussions where students explain their models and reasoning to their peers and they are encouraged to give feedback to their peers. This promotes collaborative learning and helps students view their work from different perspectives.

  Example: "I like how you visualized the data, but have you thought about including a trendline to show the relationship more clearly?"

2) Self-Reflection and Peer Assessment

- Reflection Prompts: During sessions or at the end of each session, students are given reflection prompts to think critically about their learning process.

  Example: "What challenges did you face while creating your Desmos model? How did you overcome them? How does your model reflect the real-world implications of the SDG you chose?"

- Peer Assessment Rubric: During the presentations, students use a rubric to evaluate their peers' projects. This encourages active listening and critical thinking.

  Example: "Rate the clarity of the problem statement on a scale of 1 to 5. Provide specific comments on how it could be improved."

- Project Rubric: A detailed rubric is shared with students at the beginning of the project, outlining the criteria for success. This helps students understand expectations and self-assess their progress.

Example: Criteria might include: clarity of all explanations, accuracy of mathematical modeling, creativity in using Desmos, depth of analysis, and effectiveness of presentation.

Formative assessment in this mini-PBL activity is not just about evaluating students' work but about guiding their learning journey. By integrating ongoing feedback, checkpoints, peer and self-assessment instructors can ensure that students not only achieve the learning objectives but also develop a deeper appreciation for the role of mathematics in addressing global challenges like the SDGs.

Conclusion

Formative assessment is a vital strategy for supporting at-risk students in university mathematics courses. By implementing a systematic, feedback-driven approach, educators can help students build confidence, improve performance, and reduce dropout rates. This guide provides a foundation for designing and implementing formative assessment systems within the context of an Erasmus+ project, fostering collaboration and innovation across institutions.

References

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