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RELEVANT ASSESSMENT AND PEDAGOGIES FOR INCLUSIVE DIGITAL EDUCATION

IO3 APPENDIX 2 - LEARNING ANALYTICS: TIPS AND TRICKS FOR TEACHERS AND INSTITUTIONS

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CONTENTS

1. BASIC TERMINOLOGY

Data analytics is an interdisciplinary scientific field analysing raw data in order to draw out meaningful, actionable insights and make conclusions. Many of the techniques and processes of data analytics have been automated into mechanical processes and algorithms that work over raw data for human use.

Learning analytics (LA) is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs.

Wider reasons to use LA: Prediction; Personalization and Adaptation; Intervention; Information Visualisation

Impact can be measured on the level of a learner, a course, an institution and a whole educational system.

Data literacy is the ability to read, understand, create, and communicate data as information.

2. HIGHER EDUCATION INSTITUTION LEVEL

2.1 INSTITUTIONAL ACTIONS:

Develop and implement **data-driven culture** and regular **data analytics training** to use artificial intelligence (AI), particularly LA, in a responsible and trustworthy way, to avoid biases.

For university **teachers**, training in using data analytics in a meaningful way is essential. There are MOOCs and online tutorials available to start with, but it is necessary to organise **institutional training** to open discussion.

LA should work under **ethical and equity principles** (fairness!). An institutional **code of practice** or at least recommendations might be developed.

Data literacy as well as **assessment literacy** need to be included into a **teachers' competences toolbox**. It can be part of a PhD program for early career teachers and/or further professional development of university teachers and staff.

Institutions should provide **support** to teachers in using LA and AI in terms of training, resources and equipment, as well as supporting staff.

The best approach is to undergo the **cycle of strategic planning**.

2.2 QUESTIONS TO BE ASKED AT AN INSTITUTION LEVEL:

- What are the **data literacy competences** of **stakeholders** (learners, teachers, developers, researchers, educational leaders, and employers) needed to effectively deploy AI-enhanced LA tools? Do these competences differentiate across learners from various disciplines and various stakeholders?
- How do end-users' **data literacy competences** associate with their **interpretation** of LA affordances, reasoning and decision-making related to the learning process while interacting with LA tools?
- How to foster **data-driven culture, digital literacy and ethical use of data** in the development of responsible AI in education?
- How to **strategically plan** and co-create LA design and resources to achieve strategic goals?

3. UNIVERSITY TEACHER LEVEL

3.1 GENERAL RECOMMENDATIONS

LA does not provide a teacher with universal rules and give general results, but should be **interpreted in a particular educational context**.

At least basic LA is available in various **e-learning tools and Learning Management Systems** (LMSs). Check the analysis provided there, but do not interpret it without studying a manual and clarifying with your colleagues what possible benefits and downsides it can have.

LA is always to a certain extent **biased**, and therefore teachers should understand what their **goal** is, as well as what are the **limitations** of a particular data analysis.

Be aware that LA can **motivate**, but also demotivate students to learn, so pay attention to types of analyses and feedback which would be more beneficial for your students' learning.

3.2 QUESTIONS TO BE ASKED BY TEACHERS:

Why do you need LA for?

Some of the possible answers:

- monitoring or evaluation of my teaching and students' learning;
- evaluation of course learning design;
- giving feedback to students to enhance their learning;
- evaluation of usefulness and upgrade of learning material;
- following and evaluating the impact of a new pedagogical approach;
- finding early indicators for success or failure;
- targeting teaching according to students' particular needs.

Based on the answer, you choose the approach, metrics, sources of data, LA method and dissemination level, as analysed below:

What data do you need? Are you going to use aggregated data results or analysis of individual student progress?

Whenever you use individual student data, you should check the reliability; consent level for using and analysing student data; fairness and ethical principles.

What LA methods do you use? Do you understand how the method works and what are its limitations?

To start with, use the methods integrated into available e-learning tools and check their limitations and manuals. For advanced use, rely on expert advice.

Who do you share your LA results with?

For example, identify potentially disengaged students, talk to them and give them advice on how to improve their learning; evaluate an assessment task or an assessment program (reliability) in order to improve it. Furthermore, aggregated data about disengaged students can be collected on the HEI level and be used as the basis to finetune learning design to meet students' specific needs.

What impact of using LA do you expect?

A possible impact can be expected on a learner, course or HEI level, but should be specified in advance. For example, the impact of LA on a course level can decrease the portion of

disengaged students and support them in better achievement of learning outcomes. A similar impact can be measured on the HEI level.

What training/support do I (teacher) need?

Planning of appropriate professional development is an essential part of the meaningful and sustainable use of LA. A HEI should collect teachers' needs for training and support, and based on that prepare training opportunities on an annual basis.

Institutional support in providing tools, equipment and resources must be part of an institutional strategy for digital transformation and/or LA implementation. Strategic planning should involve stakeholders, particularly teachers and students.

Summary table to plan the activities of using LA:

Why LA?	**Where/What data?**	**What LA methods?**	**With whom are you sharing?**	**What impact do you expect?**	**What training/support do I (teacher) need?**
				Learner Course HEI	

3.3 EXAMPLES WITH SUGGESTIONS FOR INTERPRETATION

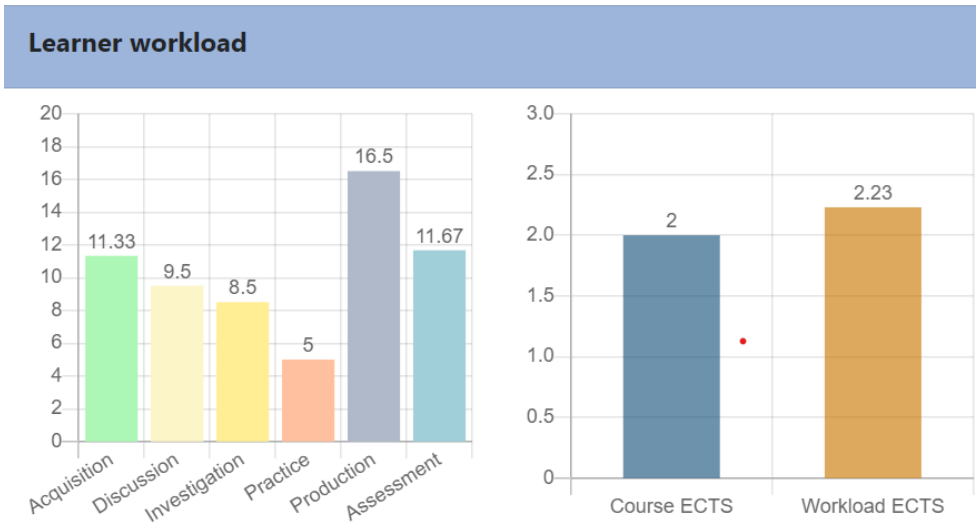
Example 1. **LA about TLA types provided combining the Learning Design tool (BDP) and LMS (Moodle)**

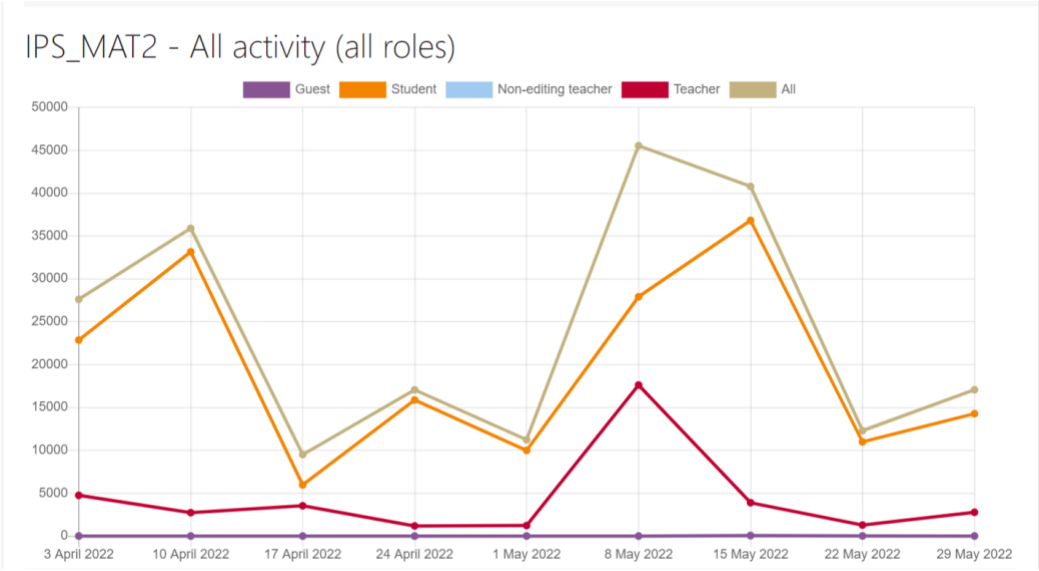
We can ask ourselves the following questions:

When are students active and engaged?
Do students in our class study only for tests?
Do students have enough time to finish all the planned activities?

What can we learn from the LA available in the BDP tool and Moodle?

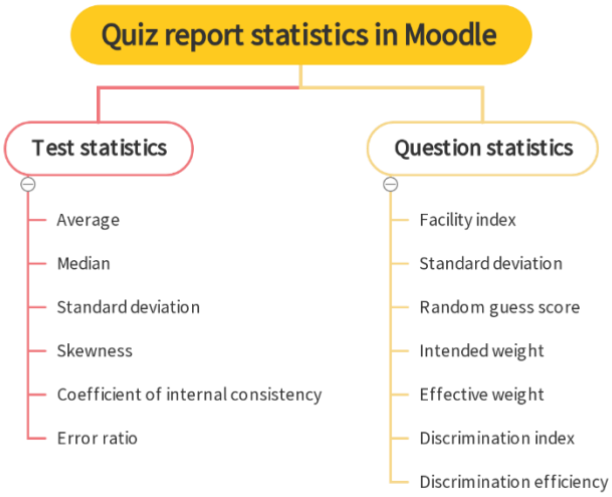
As expected, students' activity and engagement varies throughout the semester. Oscillations are visible and can be connected with summative assessment. Activity analysis shows us when students are active and engaged. It is noticeable that activity increases before tests, so we can say that students in our class study for the tests. At these times, there are peaks in students' activity and use of materials, and after tests, it is visible that engagement decreases. The rest of the time during the semester, students use materials and tools for formative evaluation, which is evident in the graph below. Smaller jumps in activity also occur in the part where we apply flipped classroom.





Example 2. Interpretation of assessment analytics in Moodle

If you want to spot tests or just questions/tasks within a test that need improvement, you can use Quiz report statistics automatically available in the LMS. The LMS (Moodle) offers two types of statistics – test statistics, giving some information about the whole test, and question statistics, on the question/task level, listed in the mind map “Quiz report statistics in Moodle” available below.



As we can see, there are several measures available on the test level. With the right amount of understanding, they can be a useful tool for spotting tests that need improvement.

If the measure of average success is not between 40% and 65%, a teacher should think about the reason for that. This could be a consequence of poor preparation for the test – see students' activity - or maybe students did not have enough time for the test – ask them through a forum or a short survey.

Median (the middle test score in a sorted list of test scores) can be used in combination with the average for spotting outliers that might skew the average. If those two values are not close, you can indicate some students with very low or very high score.

Standard deviation is a measure of the spread of scores around the average. Aim for values between 12% and 18%. A smaller value suggests that scores are too "bunched up".

Skewness is a measure of the asymmetry of the distribution of scores. Zero implies a perfectly symmetrical distribution, positive values imply a 'tail' to the right and negative values a 'tail' to the left. Aim for a value of -1.0. If it is smaller, it may indicate the lack of discrimination between students who do better than the average (similarly with values greater than 1.0).

Coefficient of internal consistency (CIC), also known as Cronbach's alpha, is a measure of internal consistency, that is, how closely related a set of items are as a group. It is considered to be a measure of scale reliability. Anything above 75% (or at least 70%) is satisfactory. A low value can indicate either that some of the questions are not very good at discriminating between students of different ability and hence that the differences between total scores owe a good deal to chance or that some of the questions are testing a different quality from the rest – i.e. the test as a whole is inhomogeneous.

Error ratio (ER) is related to CIC. It estimates the percentage of the standard deviation which is due to chance effects rather than to genuine differences of ability between students. Values

of ER in excess of 50% cannot be regarded as satisfactory: they imply that less than a half of the standard deviation is due to differences in ability and the rest to chance effects.

You can see in table "Mathematics 1 – Test statistics" how these test statistics were taken into account within the Mathematics 1 course (first year undergraduate students).

Mathematics 1 – Test statistics

Test statistics	Mid-term test 1, N=311	Mid-term test 2, N=304	Mid-term test 3, N=285
Average (40% - 65%)	10,13/20 - 50,66 % ☺	11,55/20 - 57,75% ☺	58,24%
Median	10,54 - 50,54% ☺	10,54 - 57,85%☺	60,54% ☺
Standard dev. 12% - 18%	13,40% ☺	16,14% ☺	20,35%
Skewness	0,0532 ☺	0,0415 ↓ ☺	-0,0445
CIC 75% (70%)	52,31% :/	61,04% ↑	66,54% ↑
Error ratio < 50% (55%)	69,06% :/	62,42% ↓ :/	57,84%↓

Facility index (FI) represents the average score of students on an item. It can help differentiate easy (FI > 65%), difficult (FI < 35%), and average (35% < FI < 65%) items. Tip: as you can see in table "Mathematics 1 – Question statistics (item analysis)", the goal is to have mostly average items with a few harder or easier ones.

The intended weight and the effective weight are intended to be compared. If the effective weight is greater than the intended weight, it shows the question has a greater share in the spread of scores than may have been intended. If it is less than the intended weight, it shows that it does not have as much effect in spreading out the scores as was intended.

Discrimination index: This is the correlation between the weighted scores on the question and those on the rest of the test.

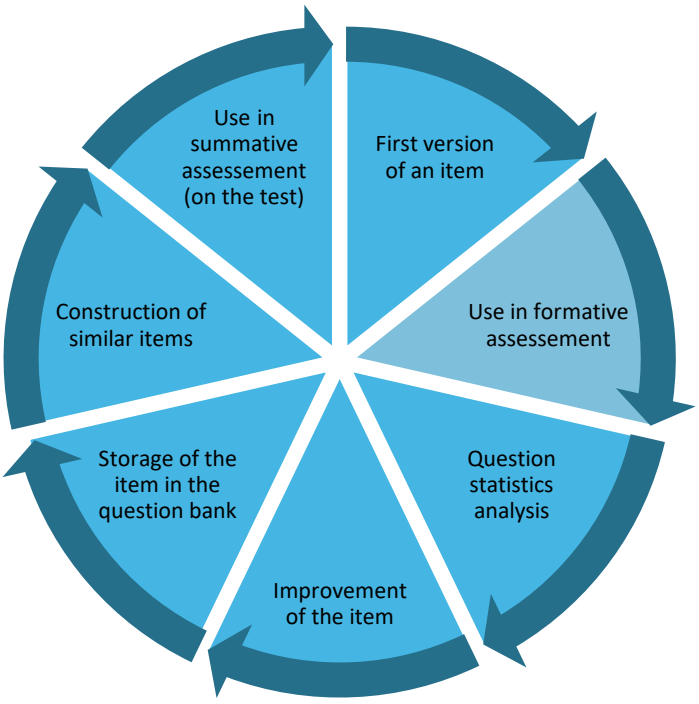
Discrimination efficiency measures how good the discrimination index is relative to the difficulty of the item. An item which is very easy or very difficult cannot discriminate between students of different ability, because most of them get the same score on that question.

As well as for test statistics, you can see in table "Mathematics 1 – Question statistics (item analysis)" how these statistics were taken into account within the Mathematics 1 course (first year undergraduate students).

Mathematics 1 - Question statistics (item analysis)

Question statistics	Mid-term test 1 – 10 tasks	Mid-term test 2 – 8 tasks	Mid-term test 3 – 8 tasks
Facility index 35-65% for average student	4 average, 3 harder, 3 easier ☺	6 average, 2 harder ☺	6 average, 1 harder, 1 easier
Effective weight Differ from intended weight up to 20%	☺	☺	☺
Discrimination indeks > 50 very good between 30 i 50 good	Good or weak :/	6 good, 2 weak ↑ :/	1 very good, 5 good, 2 weak ↑ :/
Discrimination efficiency 30% - 70%	:/	↑ :/	↑ :/

How to create an "ideal" question/task?



Example 3. Learning material evaluation

If you want to identify learning material in a course that needs improvement, you can use statistics in the LMS related to online learners' engagement with learning materials (video, reading, apps, etc.), learner feedback, and completion rates. You can spot (Activity analysis) if your students work more with shorter video lectures (5-15 minutes), videos of whole lectures (45 minutes) or reading materials. But it is not the only proxy of the usability or quality of the material. You can also ask them, in a short questionnaire, which they prefer, why and what for. You can relate those results with the clustering of students and identify what material and how successfully students are using. Based on that, recommendations for all students can be issued, but also teachers can use feedback to optimise their workload and produce more meaningful learning material. But we should take into account that not all students have the same needs or learning habits and that a one-size-fits-all approach is not feasible.

Furthermore, LA can link learning material use with assessment. For example, perhaps students are consistently failing a test because they are skipping a specific content resource (video, app, practice or a book chapter). A teacher can address the issue by restricting access to the quiz until a learner has covered a relevant learning resource.

Example 4. Quick LA glimpse before preparation of a lecture or other teaching and learning activities

Imagine you are a teacher using the flipped classroom approach, who gave students a task to prepare, and now you are designing your lecture. Thinking of how to design it, you can look at some simple LA in the LMS, such as activity and engagement of your students with

materials, results of a pre-quiz on basic notions related to the topic and questions posed by students in a discussion forum.