Data for Learning in Engineering Education

Marcus Specht, Selma van Esveld, Jacopo De Stefani,
Ted Adrichem, Andra Gherghiceanu

A white paper of 100 DAYS OF DATA FOR LEARNING Organised by

4TU.CEE · Centre for Education and Learning Leiden-Delft-Erasmus Universities · TUDelft Teaching & Learning Services · TUDelft Extension School · TUDelft Teaching Academy

Data for Learning in Engineering Education

Colophon

Summary

For the past decades, the role of data has been ever growing in almost all fields - learning (and education) not excluded. But what is actually meant by 'Data for Learning'? What data is available at TU Delft to support teaching and learning? In what way is it being used? For what purpose – and with which impact? And what are the challenges involved? These have been the questions which motivated the team of '100 DAYS OF... DATA FOR LEARNING' to shape the program.

This paper outlines the findings of our 100+ days' exploration. The aim of this paper is to raise awareness, understand conditions and needs, and discuss concerns and opportunities of (further) development of using 'Data for Learning' within the context of TU Delft Education.

In the '100 DAYS OF... DATA FOR LEARNING' we have organised peer exchange among scientific staff and educational support, students, and lecturers. We have held journal clubs, invited science speaker sessions, and a hackathon event to understand the role and potential of data to support teaching and learning. In detail this included twelve Science speaker sessions in which a variety of topics has been presented and discussed about current applications of data in teaching and learning support as also fields of tension and challenges. In the 2022 CEL (Centre for Education and Learning) annual meeting, experts and interested participants convened for three keynotes and eight workshops on the topics of Learning Analytics and Data for Teaching and Learning.

In the hackathon initiative a dataset of real student data from a higher education institution in the Netherlands was collected and presented to different stakeholders for discussion and analysis. On one hand, students had the possibility to analyse the data to extract insights that could support the work of educational advisors. On the other hand, practitioners reflected on the current status of learning data and discussed improvements or potential future projects.

Overall, a variety of stakeholders from the TU Delft, on a national and international level, have been involved and contributed to the 100 Days. This has created awareness and new initiatives about the potential and challenges of 'Data for Learning'. This brochure gives background, details, and starting points for further exploration of this important topic for the future of education.

Throughout the document you will find blocks of text that are clickable.
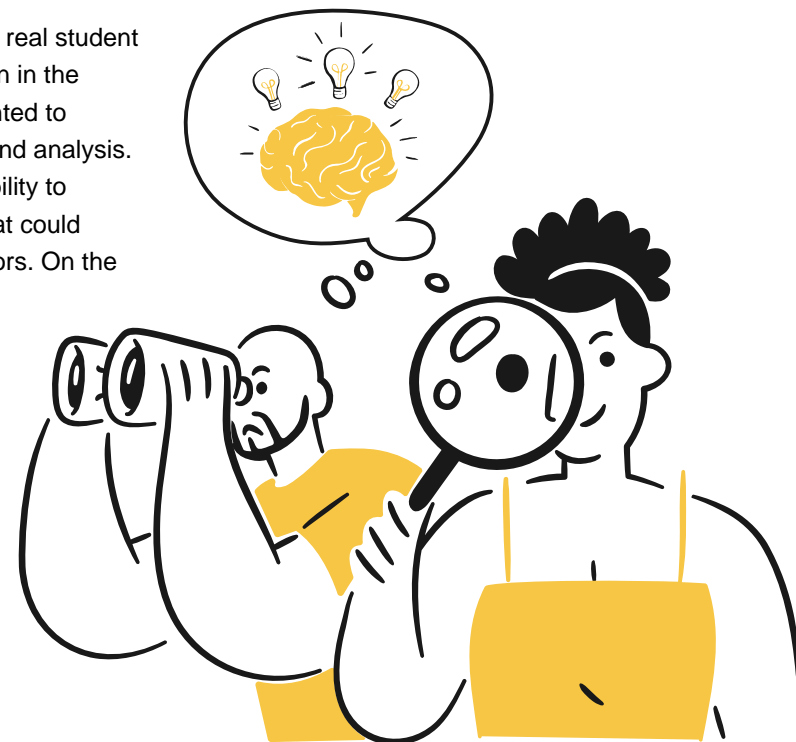
Table of Contents

"In the last fifteen years, Learning Analytics has developed into one of the biggest research fields in Educational Technologies."

1

2

3

4

5

6

7

8

Introduction and background

Data is all around us in our daily lives. In the digital transformation, data is the driving force and a key asset for companies building their business models. In education, data has always played a central role: from assessment of students learning to giving feedback. Since the 1990s, collecting data from learners interacting with software systems has developed several areas of educational innovations and applications. Intelligent Tutoring Systems have used the problem solving activities of learners to give feedback and select tasks for learners (Mory, 2004). Adaptive educational hypermedia has developed personalised learning solutions based on the click-data of learners and supported course navigation and adaptive guidance (Brusilovsky, 2001). Since 2010 also sensor-based systems have tracked learning activities such as presentation skills, physical activities or others and supported learners with intelligent feedback (Schneider et al., 2015).

In the last fifteen years Learning Analytics has developed into one of the biggest research fields in Educational Technologies supporting dropout prediction, learner self-regulation, or teaching analytics and data-informed instructional design. Learning Analytics and Educational Data Mining include applications of methods and instruments for data collection, and aggregation and analysis for different target and stakeholder groups as learners,

teachers, and educational program managers as policy makers (Greller & Drachsler, 2012). Furthermore, the massive collection of data and usage also paved the way for data-driven Artificial Intelligence Applications in Education in the areas of prediction, personalisation, assessment and intelligent tutoring (Zawacki-Richter et al., 2019).

In general, data often comes from user activities which are logged in software systems, teacher assessment and feedback data, or metadata of learning content and automatic content analysis tools. All these different data sources can be combined in educational innovations and teaching and learning support. In the context of this programme, '100 DAYS OF DATA FOR LEARNING' refers to gathering and using of data for and about learning and education.

With the General Data Protection Regulation (GDPR), Europe has set an international standard for handling personal data, especially in digital contexts, ensuring user privacy and control of data. Recently the European Council has identified Education as one of the high risk fields for using personal data (Tuomi, 2018). This illustrates the field of tension considering the topic of 'Data for Learning'. While, on one hand, personalised feedback and learning support is one of the most

effective means in teaching, the use of personal data in educational settings is a highly sensitive matter. Nevertheless, for these challenges, the 100 Days inspired discussions and introduced efficient methods for handling these topics in organisations (Drachsler & Greller, 2016).

In this report, we will summarise the discussions and findings of the '100 DAYS OF DATA FOR LEARNING' programme which took place from September 2022 until February 2023 at TU Delft. In short, the programme highlighted challenges, opportunities, and risks, and inspired discussions on many questions around data for and about learning and education. In the following, we will summarise the topics, some findings, and reflections from the 100 Days considering the following questions:

- What are best practices for Learning Analytics?
- What type of data is available at the TU Delft about learning and educational processes?
- How is the data used and valuable for different stakeholders?
- What are success stories and use cases for activating data in your education and what are starting points for your personal way forward?

"Several studies and frameworks from the Learning Analytics community have highlighted different stakeholder groups to make use of data."

Best practices of using data and for whom?

Data for whom and which needs?

Several studies and frameworks from the Learning Analytics community have highlighted different stakeholder groups who make use of data, i.e. learners, teachers, researchers, and policy makers. In a recent analysis at Erasmus University, different needs, concerns, and conditions for the introduction of data use in education were highlighted. While student needs appear centered around a personal curriculum and goal setting support, lectures stress the importance of overviews to frequent errors, dashboards, and support for giving advice to students. As main concerns, students highlight the availability of their data for too many people and also a "verschoolsing" of the system controlling their activities. Teachers are seen as potentially drawing the wrong conclusions and simplifying learning to numbers and assessment.

Also, on an organisational level, policies and instruments have been developed to understand the needs for adaptation of learning analytics and the development of organizational-specific approaches for learning analytics. The SHEILA project has developed several instruments for data collection in organisations which allow for the analysis of different stakeholders concerns and needs and potential instruments and learning analytics policies[1].

What data is used for what purpose?

Most classical learning analytics applications build on data from learning management systems and existing infrastructure tools in higher education organisations. Recently, many more sources of data have been identified to help lecturers and students to give and get guidance, structure lecturing, give feedback to each other, and more.

Section 3 of this white paper gives an overview of the data available about learning activities from different learning applications supported at TU Delft. The most popular applications of learning traces are learning analytics dashboards and recommender systems which allow for the personalised analysis of activities, support of meta-cognitive activities as reflection, and differentiation between students.

Target groups for learning analytics are mostly teachers and learners. Teacher focused applications, including dashboards to get an overview of learning activities and course progress, are used to collect course specific questions or aggregation of assessment of student solutions. Student focused applications mostly support personal planning, goal setting, reflection, and monitoring of learning activities. Management oriented dashboards support program monitoring and optimisation of study advise.

In the last fifteen years, the research community has developed a lot of so-called "indicators", which consist of aggregations for data traces from different sources, and approaches how to use these indicators for teaching and learning support.

[1] https://sheilaproject.eu/
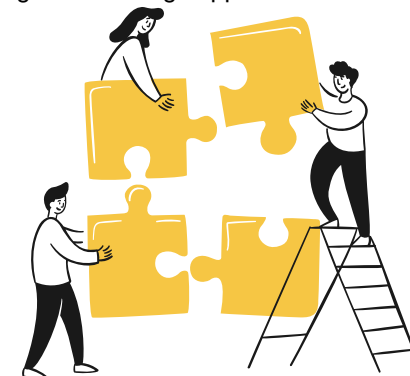
What data tells

Considering the collection, aggregation, and interpretation of data, data literacy of learners and educators becomes important. From current initiatives at TU Delft, lots of data aggregation is driven by individual lecturers initiatives. Building on either personal reflection activities of learners in journals or learner activities in online systems such as Brightspace or other specific tools developed in different faculties.

For lecturers, collected data often helps to support decisions in the teaching process as:
- Are my students on track with their assignments?
- Are there specific students that would need specific support or feedback?
- Are there specific questions that are discussed a lot from my last lecture?
- Are there gaps or unused learning materials in my course?
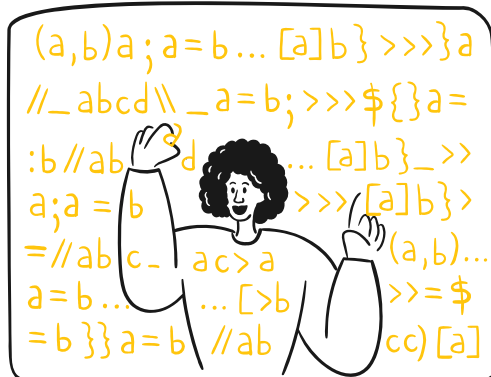
For learners, data and analytics can help with information as:

- What are my specific goals in this course and did I achieve my goals?
- What are my specific strengths and weaknesses working on assignments and what are my solutions to these?
- What challenges do my peers see and what are the hot topics in the course?
- How could I enhance my learning strategies and become more efficient?

For program managers a lot of information is related to managing the portfolio:

- What courses in the program have a high number of enrollments?
- Are there gaps in the program to develop programs with high retention?
- What are specific characteristics of courses in the program and are these aligned?
- Can individual trajectories be identified and therefore new paths in the programme be identified?

1
2
3
4
5
6
7
8
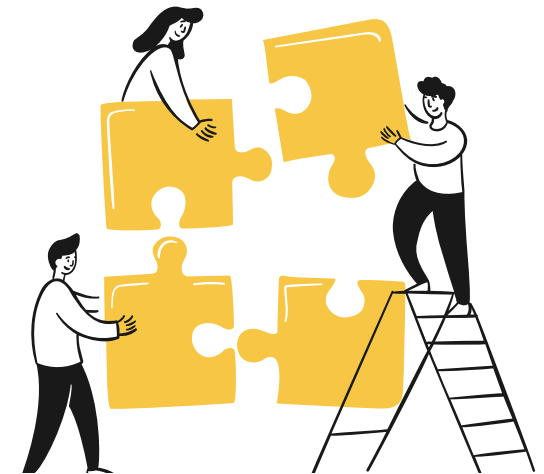
An application: the Learning Tracker

"The best teachers are those who show you where to look, but don't tell you what to see. (Alexandra K. Trenfor)"

In 2015 the TU Delft Extension School looked at the problem on how to help learners to be more self-directed and self-regulated in their learning trajectories when learning with MOOCs.

Many learners dropped out, lost motivation, or had unrealistic expectations about the learning trajectory. Together with the Leiden-Delft-Erasmus Center the Software Technology Department developed a tool to support learners in reflection and self-regulation throughout a MOOC learning trajectory. The first implementation can be found published at the TUD repository and the Learning Analytics conference in 2016 (Jivet, 2016, Davis et al.. 2016).

This started a PhD project with several highly cited papers and a cum laude PhD in 2021 by Dr. Ioana Jivet. In the further research a better understanding of the design factors of Learning Analytics Dashboards (LAD) was established for supporting learners and teachers as well as the effects of specific indicators in shaping feedback.

Practical applications have been developed for MOOCs as also for Learning Management Systems and have been embedded in Delft and Rotterdam MOOCs.

A further analysis of this also had a big impact on the Learning Analytics community and the shaping of Learning Dashboards in digital learning environments.

Jivet, I. (2016). The Learning tracker: a learner
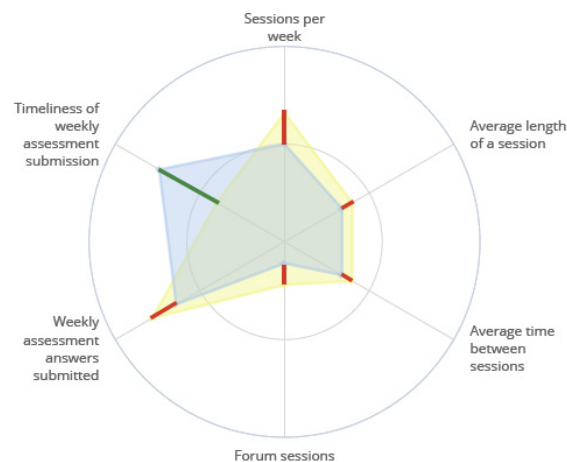
dashboard that encourages self-regulation in MOOC learners.

Davis, D., Chen, G., Jivet, I., Hauff, C., & Houben, G. J. (2016, April). Encouraging Metacognition & Self-Regulation in MOOCs through Increased Learner Feedback. In LAL@ LAK (pp. 17-22).

Jivet, I., Scheffel, M., Specht, M., & Drachsler, H. (2018, March). License to evaluate: Preparing learning analytics dashboards for educational practice. In Proceedings of the 8th international conference on learning analytics and knowledge (pp. 31-40).

Jivet, I., Scheffel, M., Drachsler, H., & Specht, M. (2017). Awareness is not enough: Pitfalls of learning analytics dashboards in the educational practice. In Data Driven Approaches in Digital Education: EC-TEL 2017, Tallinn, Estonia, September 12–15, 2017, Proceedings 12 (pp. 82-96). Springer International Publishing.

"Currently there is a major gap between the theoretical potential and the actual use of data."

100 DAYS OF DATA FOR LEARNING

1
2
3
4
5
6
7
8

The TU Delft data landscape

The educational landscape at TU Delft is heterogenous and broad. The programmes offered by the university range from short online courses for working professionals to minors, full bachelor, and master degrees for campus students[2]. Running each of these programmes creates digital data traces containing information on learning and educational processes. The source of these traces can be institution-wide software databases and applications as well as more specialised tools used only by a subset of faculties, departments, courses, or even students. In addition to these sources, researchers can generate their own data sources. An example of such a source is the outcomes of conducted surveys among teaching staff or students.

In the following, we would like to differentiate the main sources of data generated by systems used in the support of teaching and learning. Demographic information of students such as age, previous education, and time enrolled are recorded in the student information system Osiris. The tooling used in TU Delft online, blended, and/or on Campus education can collect information about students in the following categories: Polling & Surveys, (Peer) Feedback, Assessment & Assignments, Collaboration & Projects, Communication, Conference call & Virtual classroom, Downloads, Peer Evaluation, Practice & interactive courseware, Software development, Videos, Lab & Fieldwork, Learning Management System (LMS), Classroom tools, and Other tools and functionalities. The TLS web pages[3] contain an overview of the available tools per category.

Within the Extension School the data from the edX learning platform is directly accessible for course evaluation, whereas the data from tooling is not always disclosed by the company that provides the tooling. Although not always directly available, data from collaboration tools used within Extension School courses, such as SketchDrive can be very informative on the interaction between students while working on course content. The edX platform data includes demographic information, forum discussions information as well as student event information (mouse-click-streams). Such a sequence of events from learners will tell course teams a lot about the learning paths that learners follow and give them feedback if the designed learning path throughout the course supports most students or should be adjusted.

In theory, the above described data sources are valuable resources to provide teaching, learning, research, and management support. However, at the moment there is a major gap between the theoretical potential and the actual use of the data. Important steps need to be done for making data available, secure, valid, and relevant for managers, lecturers, and learners.

[2] https://www.tudelft.nl/en/education/programmes, visited 21-07-2023

[3] https://teaching-support.tudelft.nl/typo3-educational-tools-overview-of-tools-used-in-education/ , https://www.tudelft.nl/teaching-support/educational-tools/remote-teaching-overview , https://www.tudelft.nl/teaching-support/educational-tools

Stakeholder	Educational Challenge, Question	Information, Data Points	Systems
Program Manager	Do we have a good programm?	Administrative student information Administrative course information	Osiris, edX Insights
Study Advisors	What path can be recommended?	Students grades, Average passing rates, Typical learning trajectory	Osiris, Tableau, Study Guide
Teachers	How well are my students on path? Are my students engaged? What do my students want?	Answers on assignments Submission dates of assignments Polling Solutions	Brightspace, edX (ELAT) ANS, Grasple, Weblab Brightspace Polls, M365 Forms, Qualtrics
Learners	What is my performance level? Am I aligned with the other students? How can I enhance my solutions?	Feedback on Assignments Peer Feedback Systems Formative Feedback Tools	Brightspace Quizzes, ANS, Grasple, Weblab, Vocareum, Feedback Fruits, Filestage, Peer Tool, Presto, Answers, Brightspace Assignments
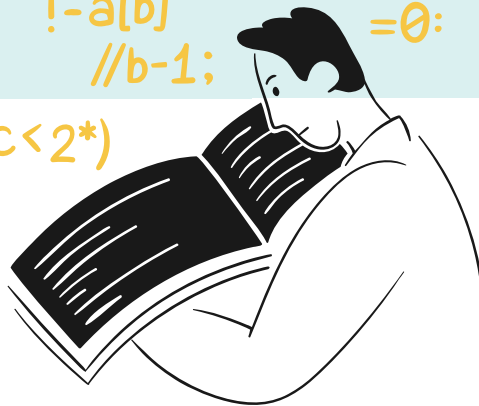
An application: the Answers platform

In 2019 the faculty of EEMCS at the TU Delft started to experiment with online learning communities for students. Basically, a collection of course related questions and answers have been connected in a secure online space in which students can ask all questions, tag their questions, and give answers, rate answers of others as also browse and search existing questions and answers. Initially a commercial solution was used, but in the next iteration the need for customisation and special analytics for the courses and student activities to support teachers and the interaction between students became obvious.

This started the development and customisation of the ANSWERS platform driven by the teaching team of Computer Science in Delft. In 2019 funded from a national research call by NWO, a project on the development of Learning Communities was started by LDE-CEL and the Computing Education Research Group (CER) at the TU Delft. After first online research into learning communities and core features of successful online learning communities the project experimented with different facilities to develop cross-sector learning networks linking universities, universities of applied science and practitioner communities in the field of the energy transition (Soleymani et. al, 2023). In search of how to apply the core findings in our education, the development of the ANSWERS platform was chosen as a candidate. The teaching team and the CER together developed Learning Analytics and community features such as gamification badges for the open-source platform and is currently evaluating these features in research. The main research question is how the answers technology has an impact on the learning experience of students and lifelong learners. This is explored with the help of analysing student and lecturer interaction on the platform and making use of Social Network Analytics to understand the added value and changes in the network structure (Soleymani et. al 2023).
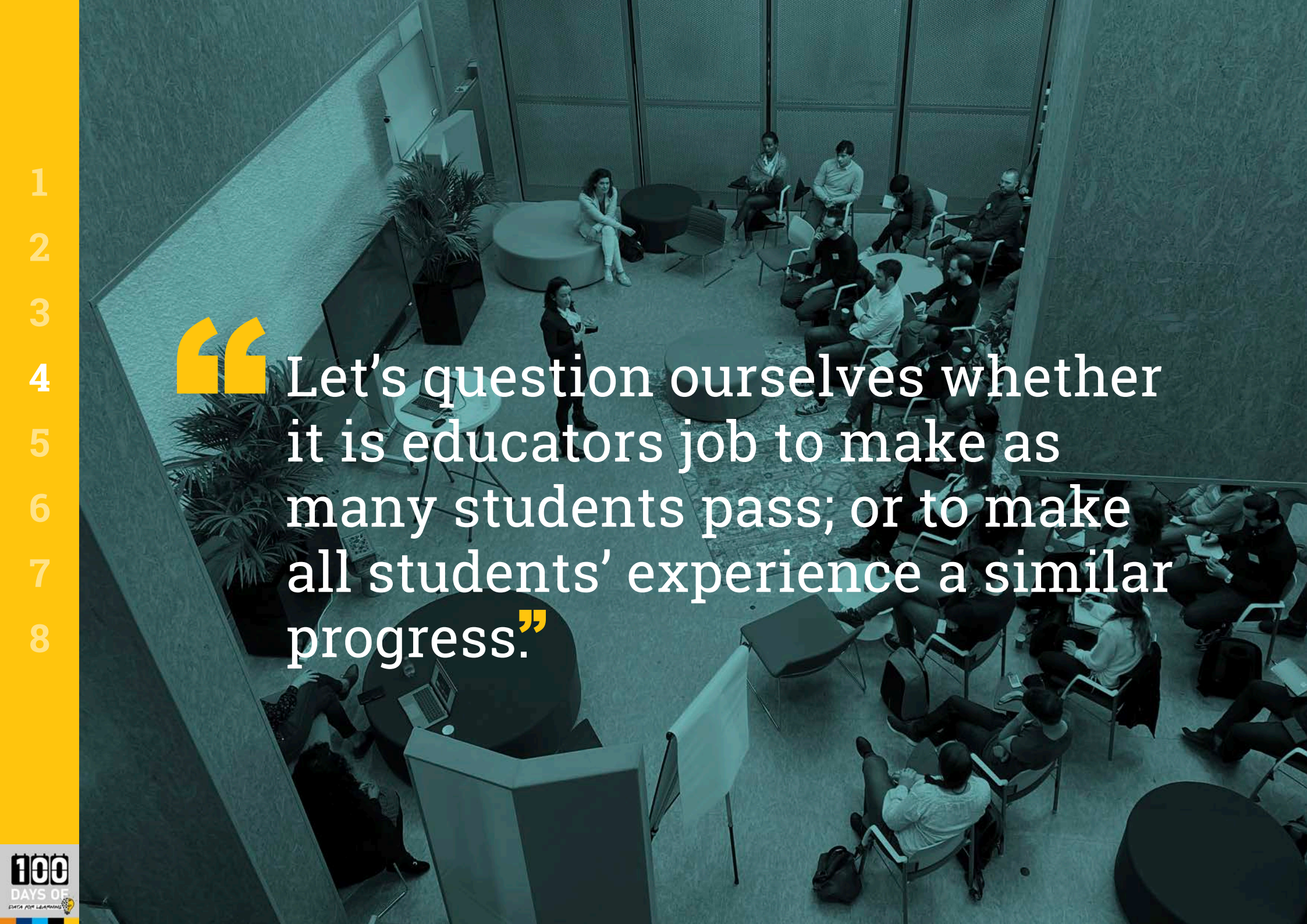
The current platform is a modification of the open-source system QPixel (https://github.com/codidact/qpixel). It is being developed further by the EEMCS CSE teaching team and CEL and is available from (https://gitlab.ewi.tudelft.nl/eip/answers/qpixel). Furthermore, current experimentation will be published in 2024 highlighting key findings from the experimentation. Hypotheses are that the gamification and learning analytics have an impact on the learning experience and perceived value of a course and that the learners dashboards also help to activate learner for social networking and knowledge exchange.

Soleymani, A., van den Brom, P., Ahmed, S., Konings, M., Sjoer, E., Itard, L., & Specht, M. (2023). Learnings Networks and Professional Development in Building Energy Management Systems Industry. Education Sciences, 13(2), 215.

Soleymani, A., Itard, L., de Laat, M., Torre, M. V., & Specht, M. (2022, May). Using Social Network Analysis to explore Learning networks in MOOCs discussion forums. In CLIMA 2022 conference.

SourceCode: https://codidact.org/, https://github.com/codidact/qpixel,
EEMCS adapation: https://gitlab.ewi.tudelft.nl/eip/answers/qpixel

"Let's question ourselves whether it is educators job to make as many students pass; or to make all students' experience a similar progress."

100 Days activities and discussions

In the '100 DAYS OF... DATA FOR LEARNING' the team organised Journal Clubs, an invited speaker series, and also Keynote Talks at special events. In the Journal Clubs, we explored and discussed several scientific papers on 'Data for Learning'. Following a flipped-classroom approach, participants read an article before the session and came together to have an guided open discussion on the article and the potential implications for Engineering Education. The core addressed in each session was:

Based on scientific literature, what lessons are there to be learned about 'Data for Learning' in relation to organising, designing and both through sophisticated technical expertise and a grounding in behavioural psychology. Secondly, we explore how educational software design informed by behavioural economics is increasingly intended to frame learner choices to influence and 'nudge' decisions towards optimal outcomes. Through the growing influence of 'data science' on education, behaviourist psychology is increasingly and powerfully invested in future educational practices. Finally, it is argued that future education may tend toward very specific forms of behavioural governance – a 'machine behaviourism' – entailing combinations of radical behaviourist theories and machine learning systems, that appear to work against notions of student autonomy and participation, seeking to intervene in educational conduct and shaping learner behaviour towards predefined aims. delivering teaching and learning at TU Delft?

Abstract. This paper examines visions of 'learning' across humans and machines in a near-future of intensive data analytics. Building upon the concept of 'learnification,' practices of 'learning' in emerging big data-driven environments are discussed in two significant ways: the training of machines, and the nudging of human decisions through digital choice architectures. Firstly, 'machine learning' is discussed as an important example of how data-driven technologies are beginning to influence educational activity.

"Instead of the machine being the expert (telling the students what to learn or study) we should aim for machines presenting a mirror to the learner."

"Next to how machines can help with our 'blind spot', they could also help in doing 'heavy lifting' in times of growing students. If 'tasks' are being split up between human teachers and supporting AI, we could create a more efficient workflow in which teachers have more time and headspace to transfer knowledge and guide students."

1
2
3
4
5
6
7
8

Abstract. Learning analytics can improve learning practice by transforming the ways we support learning processes. This study is based on the analysis of 252 papers on learning analytics in higher education published between 2012 and 2018. The main research question is: What is the current scientific knowledge about the application of learning analytics in higher education? The focus is on research approaches, methods, and the evidence for learning analytics. The evidence was examined in relation to four earlier validated propositions: whether learning analytics i) improve learning outcomes, ii) support learning and teaching, iii) are deployed widely, and iv) are used ethically. The results demonstrate that overall there is little evidence that shows improvements in students' learning outcomes (9%) as well as learning support and teaching (35%). Similarly, little evidence was found for the third (6%) and the forth (18%) proposition. Despite the fact that the identified potential for improving learner practice is high, we cannot currently see much transfer of the suggested potential into higher educational practice over the years. However, the analysis of the existing evidence for learning analytics indicates that there is a shift towards a deeper understanding of students' learning experiences for the last years.

"Let's question ourselves whether it is an educator's job to make as many students pass; or to make all students experience similar progress. By changing 'lenses' through which you look at learning analytics, the impact of it on education might vary. Should learning analytics help educators in selecting who passes or should it help to select more carefully?"

1
2
3
4
5
6
7
8

Abstract. The widespread adoption of Learning Analytics (LA) and Educational Data Mining (EDM) has somewhat stagnated recently, and in some prominent cases even been reversed following concerns by governments, stakeholders, and civil rights groups about privacy and ethics applied to the handling of personal data. In this ongoing discussion, fears and realities are often indistinguishably mixed up, leading to an atmosphere of uncertainty among potential beneficiaries of Learning Analytics, as well as hesitations among institutional managers who aim to innovate their institution's learning support by implementing data and analytics with a view on improving student success. In this paper, we try to get to the heart of the matter, by analysing the most common views and the propositions made by the LA community to solve them. We conclude the paper with an eight-point checklist named DELICATE that can be applied by researchers, policy makers, and institutional managers to facilitate a trusted implementation of Learning Analytics.

"Big brother collecting our data gives most of us an unsafe feeling. The same holds true for our students. However, this effect might be enhanced by the multitude of cookie walls and data breaches they are faced with every day. To some extent, resistance against learning analytics might (partially) be because of a general fear of losing control of one's data instead of worries about sharing data with the university."

"Using data in a responsible way is very important. However, it is also prone to take up a lot of our time. I can imagine that a lot of professionalisation and support is needed to ensure that data will be collected and used in the right way."

"Regardless of whether collecting learner data is something new or something that has been around forever, we have to act upon the fear and worries that are (increasingly) rising the past years. What are ways to increase awareness of responsible use of 'Data for Learning'?"

100
DAYS OF
DATA FOR LEARNING

"We approach this question through the lens of thinking about developing both 'for humans' and 'with humans'."

Science speakers and topics discussed

Title: Advancing regulation in collaborative learning with AI

Abstract: There is a global consensus that a new set of uniquely human skills and competencies will be necessary to succeed in a rapidly changing world, especially those that machines cannot match or replicate. These skills and competencies are central to research on regulation of learning in collaborative contexts, namely socially shared regulation of learning (SSRL). In this talk, Sanna introduces SSRL and how multimodal analytics and AI-based methods have helped us to progress in that research. In doing so, she underlines how systematic understanding of human learning process is needed to leverage the full potential of data to help learners and AI to work and learn together.

Title: Goal Setting and Learning Analytics: what can students learn from Dashboards who needs to be in control

Abstract: In this talk, Ioana Jivet will address goal setting and learning analytics by presenting the relationship between students, educational dashboards, and learning analytics. Ioana will dive into how students can utilise LA tools such as educational dashboards to enhance their educational experiences. In doing so, she will cover how interpreting this information can empower students to take control of their learning journeys, making informed decisions about their progress and areas needing improvement.
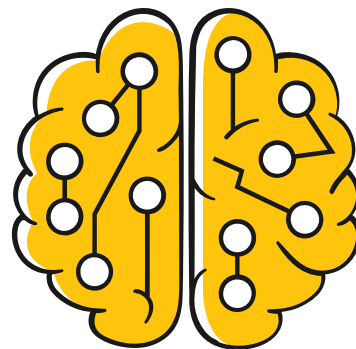
Title: Introducing the 100 DAYS OF… Data for Learning Hackathon

Abstract: In this talk, Michael Wolfindale briefly covers how speculative methods — building on concepts from speculative design, design fiction, and critical design — may be one approach to consider for such a challenge. After showing several examples from the literature. In particular, drawing inspiration from Jen Ross's (2017; 2022) recent work on speculative methods in digital education research, we will move to an open discussion on how these and related methods might be employed in our institutions and research.

1
2
3
4
5
6
7
8

Title: Cultivating a Learning Analytics Culture at UTS: Boardroom, Staff Room, Server Room, Classroom

Abstract: In this talk, Simon describes and reflects on the last eight years at the University of Technology Sydney, inventing, piloting, and evaluating Learning Analytics tools, specifically, interactive tools focused on data-driven personalised feedback, integrated with the institution's learning technology ecosystem, and accompanied by staff training and support. Simon summarises this as conversations in the Boardroom, the Staff Room, the Server Room and the Classroom, reflecting on the different levels of influence, partnership, and adaptation required to introduce and sustain novel technologies in the complex system that constitutes a university. The focus is very pragmatic, documenting aspects of our work that are typically not the focus in research papers, although the research-based invention and gathering of evidence is central to our modus operandi, and will be mentioned as relevant.

Olga Viberg
Science Speaker session
23 November 2022

Title: Designing Culturally Aware Learning Analytics for Improved Learning at Scale

Abstract: Learning analytics (LA) have been implemented in different countries with the purpose of improving learning and supporting teaching; yet, largely at a limited scale and so far with limited evidence of achieving their purpose. Even though some solutions are promising, their transfer from one country to another might prove challenging and sometimes impossible due to various technical, social, contextual and cultural factors. In this talk, Olga argues for the importance of addressing stakeholders' cultural values, which have been underexplored by the LA community, when designing and implementing LA services. Viewing culture from a value-sensitive perspective, the impact of individuals' cultural values on the design and evaluation of LA systems as well as on the stakeholders' privacy concerns in LA will be exemplified, based on the results of our recent research efforts. Finally, a set of design implications for culturally aware and value-sensitive learning analytics services and related future research directions will be presented.

Hendrik Drachsler
CEL Annual Meeting Keynote
7 December 2022

Title: Designing highly-informative competency-driven feedback with learning analytics

Abstract: Highly informative and competency-based feedback is costly and can be best given in small teacher-to-learner settings. According to research, feedback has a powerful effect on learning success; for Highly-informative Competency-based Feedback (HICF), even higher effects are measured. HICF provides actionable feedback that goes beyond correct or wrong replies. It offers the right solutions, possibilities for improvement, hints for self-regulation, and suggestions for effective learning strategies. Such feedback provides suitable conditions for effective metacognitive control of the learning process. Until a few years ago, it was very time-intensive to provide HICF in class; and simply not possible to provide HICF at large-scale university lectures due to a lack of personnel. But with the help of computers and other digital devices, we can design data-enriched learning activities that open up far-reaching possibilities to provide HICF. Within the talk, Hendrik will demonstrate how data-enriched learning activities are designed with domain experts, how the group curates a knowledge base on effective learning analytics indicators, and how the data-enriched learning activities are researched in experimental settings.

Title: Cultures of Learning Analytics: Understanding and Designing for Variation in Data Use

Abstract: To make a difference in the world, LA tools must not only be technically robust but also useful to real people and able to articulate with existing pedagogical practices. A move towards developing and using such tools can be seen as being part of a larger process of developing a culture of learning analytics. But exactly what kinds of learning analytics cultures do we want to develop and how can we best go about this? In our work at NYU-LEARN we approach this question through the lens of thinking about developing both "for humans" and "with humans," trying on both sides of the equation to engage, rather than erase, the rich variation in ways that humans go about the business of teaching and learning. In this talk, Alyssa will share work from two LA research projects, one reporting an on-the-ground investigation into the different ways that instructors come to use analytics to inform their teaching, and the other describing a participatory design process for actionable student-facing analytics involving multiple stakeholders.

"The education, the students and the staff members will definitely be better for it."

100 DAYS OF DATA FOR LEARNING

This is just the beginning... Where to start?

1
2
3
4
5
6
7
8

In general, this report can give you an overview of what kind of questions and challenges Learning Analytics can support and for which approaches there are already solutions in place at TU Delft.

TU Delft has a rich and powerful data landscape with potential for personalised support for lecturers, learners, and program managers to enhance the quality and personal relevance of engineering education.

To unfold the full potential of Data and Analytics for the different target groups, several steps need to be taken, such as creating a **Policy for Data for Teaching and Learning**. This brochure highlights methods and approaches for establishing such. Second, a shared culture for embracing actionable insights from Data must grow. **Developing local best practices** building on course and teaching practice are powerful means to do so but also students using **the power of reflection and self-regulation** for their learning journey are important steps.

For lecturers, you can find a variety of examples of the videos and scientific evidence for what works and when it works in the recordings linked in this document. Classical starting points are teaching dashboards, predictive analytics, and performance analytics.

For learners, we need to create the ground for developing a culture building on secure, privacy ensured, and trustful data. We understand that Learning Analytics can easily develop into a "Big Brother" or "Back to School" setting, but we all strive for better teaching and learning. Using data for empowering learners to become self-regulated, responsible, and active, and understanding their own learning strategies and learning to learn is a lifelong endeavour our whole university strives to support. In that sense, learners can be very active in demanding transparency, early formative feedback, monitoring of personal progress, and smart feedback solutions to make the best of your learning experience.

These ambitions confront management with challenging decisions and steps to make. TU Delft is an international leader in engineering education, and has all facilities and resources necessary to make learning personal, of high quality, and use the enhanced power of feedback from lecturers, data and, intelligent systems. The translation of all the potential and facilities into our daily practice of teaching and learning is a joint journey framed by important values and an educational vision for responsibility, active learning, and resilience, and based on rich feedback, self-regulation, and trust in yourself and your university.

References

In the article, text references to sources were written in black and in green. The black sources are references as we are used to reading them: they give evidence for what it says. The green sources are articles or other information that deal with the subject and are intended for those interested in the topic; as a start to further reading. Below, all sources (black and green) are organised alphabetically.

Argyris, C. (1982). Reasoning, learning, and action : individual and organizational.

Argyris, C., Schön, D. A., & n, D. A. S. (1978). *Organizational Learning: A Theory of Action Perspective*. Addison-Wesley Publishing Company. https://books.google.nl/books?id=2aYOAQAAMAAJ

Asselin, M. E., & Fain, J. A. (2013). Effect of reflective practice education on self-reflection, insight, and reflective thinking among experienced nurses: A pilot study. *Journal for nurses in professional development, 29*(3), 111-119.

Baars, M., Zafar, F., Hrehovcsik, M., de Jongh, E., & Paas, F. (2022). Ace Your Self-Study: A Mobile Application to Support Self-Regulated Learning. *Front Psychol, 13*, 793042. https://doi.org/10.3389/fpsyg.2022.793042

Beard, C. (2018). Learning experience designs (LEDs) in an age of complexity: time to replace the lightbulb? *Reflective Practice, 19*(6), 736-748. https://doi.org/10.1080/14623943.2018.1538962

Bell, N., & Attardo, S. (2010). Failed humor: Issues in non-native speakers' appreciation and understanding of humor. *7*(3), 423-447. https://doi.org/doi:10.1515/iprg.2010.019

Bennett-Levy, J., & Padesky, C. A. (2014). Use it or lose it: Post-workshop reflection enhances learning and utilization of CBT skills. *Cognitive and Behavioral Practice, 21*(1), 12-19.

Broadbent, J., Panadero, E., & Fuller-Tyszkiewicz, M. (2020). Effects of mobile-app learning diaries vs online training on specific self-regulated learning components. Educational Technology Research and Development: *A bi-monthly publication of the Association for Educational Communications & Technology, 68*(5), 2351-2372. https://doi.org/10.1007/s11423-020-09781-6

Brooks, B., Schaab, K., & Chapman, N. H. (2019). Integration and Metacognition: Engaging Metacognitive Capacity Building Strategies to Enhance Interdisciplinary Student Learning. *Issues in Interdisciplinary Studies, 37*(1), 23-53.

Cotton, A. H. (2001). Private thoughts in public spheres: Issues in reflection and reflective practices in nursing. *Journal of Advanced Nursing, 36*(4), 512-519. https://doi.org/10.1046/j.1365-2648.2001.02003.x

Dabbagh, N., & Kitsantas, A. (2012). Personal Learning Environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. *The Internet and Higher Education, 15*(1), 3-8. https://doi.org/10.1016/j.iheduc.2011.06.002

de la Croix, A., & Veen, M. (2018). The reflective zombie: Problematizing the conceptual framework of reflection in medical education. *Perspectives on Medical Education, 7*(6), 394-400. https://doi.org/10.1007/s40037-018-0479-9

Diefes-Dux, H. A., & Cruz Castro, L. M. (2022). Reflection types and students' viewing of feedback in a first-year engineering course using standards-based grading. *Journal of Engineering Education, 111*(2), 283-307.

Dirkx, J. M. (2001). The power of feelings: Emotion, imagination, and the construction of meaning in adult learning. *New Directions for Adult and Continuing Education, 2001*(89), 63.

Dirkx, J. M. (2006). Engaging emotions in adult learning: A Jungian perspective on emotion and transformative learning. *New Directions for Adult and Continuing Education, 109*, 15-26.

Dollinger, M., Lodge, J., & Coates, H. (2018). Co-creation in higher education: towards a conceptual model. *Journal of Marketing for Higher Education*, 1-22. https://doi.org/10.1080/08841241.2018.1466756

Edwards, G., & Thomas, G. (2010). Can reflective practice be taught? *Educational Studies, 36*(4), 403-414. https://doi.org/10.1080/03055690903424790

Edwards, S. (2017). Reflecting differently. New dimensions: reflection-before-action and reflection-beyond-action. *International Practice Development Journal, 7*(1).

Ertmer, P. A., & Newby, T. J. (1996). The expert learner: Strategic, self-regulated, and reflective. *INSTRUCTIONAL SCIENCE, 24*(1), 1-24.

Fleck, R., & Fitzpatrick, G. (2010). Reflecting on reflection framing a design landscape. In *Proceedings of the 22nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction* (pp. 216-223). https://doi.org/10.1145/1952222.1952269

Gordijn, F., Eernstman, N., Helder, J., & Brouwer, H. (2018). *Reflection methods: practical guide for trainers and facilitators: Tools to make learning more meaningful.* Wageningen Centre for Development Innovation.

Guo, L. (2022). How should reflection be supported in higher education? - A meta-analysis of reflection interventions. *Reflective Practice, 23*(1), 118-146. https://doi.org/10.1080/14623943.2021.1995856

Hamza, D. M., & Regehr, G. (2021). Eco-normalization: Evaluating the longevity of an innovation in context. *Academic Medicine, 96*(11S), S48-S53.

Hargreaves, J. (2004). So how do you feel about that? Assessing reflective practice. *Nurse Education Today, 24*(3), 196-201.

Harlim, J., & Belski, I. (2013). *Educating a reflective engineer: learning from engineering experts.*

Hilary Brown, R. D. S., Joe Norris. (2016). Forms of practitioner reflexivity, Critical, Conversational, and Arts-Based Approaches. https://doi.org/https://doi.org/10.1057/978-1-137-52712-7

Hirsch, P. L., & McKenna, A. F. (2008). Using reflection to promote teamwork understanding in engineering design education. *International Journal of Engineering Education, 24*(2), 377.

Hong, H.-Y., Lin, P.-Y., Chai, C. S., Hung, G.-T., & Zhang, Y. (2019). Fostering design-oriented collective reflection among preservice teachers through principle-based knowledge building activities. *Computers & Education, 130*, 105-120. https://doi.org/10.1016/j.compedu.2018.12.001

Immordino-Yang, M. H., & Damasio, A. (2007). We feel, therefore we learn: The relevance of affective and social neuroscience to education. *Mind, brain, and education, 1*(1), 3-10.

Jordan, M. (1997). I've missed more than 9,000 shots in my career. I've lost almost 300 games. Twenty-six times, I've been trusted to take the game winning shot and missed. I've failed over and over and over again in my life. And that is why I succeed."

Keestra, M. (2017). Metacognition and Reflection by Interdisciplinary Experts: Insights from Cognitive Science and Philosophy. *Issues in Interdisciplinary Studies*(35), 121-169.

Kennedy, R. F. (1962). "Only those who dare to fail greatly can ever achieve greatly.".

Lindsey, A., King, E., Amber, B., Sabat, I., & Ahmad, A. Examining Why and for Whom Reflection Diversity Training Works. *Personnel Assessment and Decisions, 5*(2).

Luft, J., & Ingham, H. (1955). The Johari window, a graphic model of interpersonal awareness. *Proceedings of the western training laboratory in group development, 246*, 2014-2003.

Luken, T. (2010). Problemen rond reflectie. De risico's van reflecteren nader bezien. *Handboek effectief opleiden, 52*, 263-290.

Mann, K., Gordon, J., & MacLeod, A. (2009). Reflection and reflective practice in health professions education: a systematic review. *Advances in Health Sciences Education, 14*(4), 595-621.

Marshall, T. (2019). The concept of reflection: a systematic review and thematic synthesis across professional contexts. *Reflective Practice, 20*(3), 396-415. https://doi.org/10.1080/14623943.2019.1622520

McKenna, A. F., Yalvac, B., & Light, G. J. (2009). The Role of Collaborative Reflection on Shaping Engineering Faculty Teaching Approaches. *Journal of Engineering Education, 98*(1), 17-26. https://doi.org/10.1002/j.2168-9830.2009.tb01002.x

Merriënboer, J. J. G. v., & Bruin, A. B. H. d. (2019). Cue-based facilitation of self-regulated learning: A discussion of multidisciplinary innovations and technologies. *Comput. Hum. Behav., 100*(C), 384–391. https://doi.org/10.1016/j.chb.2019.07.021

Meyer, E. (2016). *The Culture Map: Decoding how people think, lead and get things done across cultures.* PublicAffairs.

Mezirow, J. (1978). Perspective transformation. *Adult education, 28*(2), 100-110.

Mezirow, J. (2000). *Learning as Transformation: Critical Perspectives on a Theory in Progress. The Jossey-Bass Higher and Adult Education Series.* ERIC.

Narain, M. (1991). *Non-Native Speakers: Problems of Language Usage.*

Ossa Parra, M., Gutiérrez, R., & Aldana, M. F. (2015). Engaging in critically reflective teaching: from theory to practice in pursuit of transformative learning. *Reflective Practice, 16*(1), 16-30. https://doi.org/10.1080/14623943.2014.944141

Picard, C., Hardebolle, C., Tormey, R., & Schiffmann, J. (2022). Which professional skills do students learn in engineering team-based projects? *EUROPEAN JOURNAL OF ENGINEERING EDUCATION, 47*(2), 314-332.

Polmear, M., Bielefeldt, A. R., Knight, D., Swan, C., & Canney, N. (2020). Exploratory Investigation of Personal Influences on Educators' Engagement in Engineering Ethics and Societal Impacts Instruction. *Science and Engineering Ethics, 26*(6), 3143-3165. https://doi.org/10.1007/s11948-020-00261-x

Poortvliet, J. (2021). *Doorgeslagen reflectiecultuur ook docenten willen het anders.* AOB.

Quintana, C., Reiser, B. J., Davis, E. A., Krajcik, J., Fretz, E., Duncan, R. G., Kyza, E., Edelson, D., & Soloway, E. (2004). A Scaffolding Design Framework for Software to Support Science Inquiry. *Journal of the Learning Sciences, 13*(3), 337-386.

Schaepkens, S. P. C., & Lijster, T. (2022). Mind The Gap: A Philosophical Analysis of Reflection's Many Benefits. *Teaching and Learning in Medicine, 1-10.*

Schön, D. A. (1983). The reflective practitioner: How professionals think in action. *The Reflective Practitioner: How Professionals Think in Action.*

Takacs, D. (2003). How does your positionality bias your epistemology?

Tsai, W., & Lau, A. S. (2013). Cultural differences in emotion regulation during self-reflection on negative personal experiences. *Cognition & emotion, 27*(3), 416-429. https://doi.org/10.1080/02699931.2012.715080

Turkle, S. (2011). *Alone together: why we expect more from technology and less from each other.* Basic Books.

Turns, J. A., Sattler, B., Yasuhara, K., Borgford-Parnell, J. L., & Atman, C. J. (2014). Integrating reflection into Engineering Education. 2014 ASEE Annual Conference & Exposition,

Usher, R., & Bryant, I. (2014). *Adult education as theory, practice and research: The captive triangle.* https://doi.org/10.4324/9780203802656

Van Merriënboer, J. J., Clark, R. E., & De Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. *Educational Technology Research and Development, 50*(2), 39-61.

Veen, M., Skelton, J., & de la Croix, A. (2020). Knowledge, skills and beetles: respecting the privacy of private experiences in medical education. *Perspectives on Medical Education, 9*(2), 111-116. https://doi.org/10.1007/s40037-020-00565-5

Verpoorten, D., Westera, W., & Specht, M. (2011). Reflection Amplifiers in Online Courses: A Classification Framework. *Journal of Interactive Learning Research, 22*(2), 167-190.

WWR, W. R. v. R. (2017). *Weten is nog geen doen; een realistisch perspectief op zelfredzaamheid.* https://www.wrr.nl/publicaties/rapporten/2017/04/24/weten-is-nog-geen-doen

Xu, X., Lu, Y., Vogel-Heuser, B., & Wang, L. (2021). Industry 4.0 and Industry 5.0—Inception, conception and perception. *Journal of Manufacturing Systems, 61*, 530-535. https://doi.org/https://doi.org/10.1016/j.jmsy.2021.10.006

List of activities and documentation 2022-2023

18 August 2022 **Programme group meeting**
Alignment of topic with other TU Delft initiatives.

26 August 2022 **Programme group meeting**
Discussion action plan, planning of activities.

27 September 2022 **Data for Learning Journal Club meeting #1**
'Machine behaviourism: Future visions of 'learnification' and 'datafication' across humans and digital technologies.'

04 October 2022 **Organisation of 100 Days-kick-off event**
Discussing and preparation of scope, activity and goals.

20 October 2022 **Kick-off event '100 DAYS OF... DATA FOR LEARNING'**
Opening with stakeholders: Interactive world café on target groups' needs, ideas and concerns.

26 October 2022 **CEL Science Speaker - Sanna Järvelä**
Advancing Regulation in collaborative learning with AI.

02 November 2022 **CEL Science Speaker - David Guralnick**
Using stories to create emotional connections in learning.

09 November 2022 **CEL Science Speaker - Iona Jivet**
Goal setting and learning analytics.

10 November 2022 **TU Delft Education Day 2022**
Poster on '100 DAYS... DATA FOR LEARNING'.

16 November 2022 **CEL Science Speaker - Michael Wolfindale**
Hackathon approach - Get involved!

23 November 2022 **CEL Science Speaker - Olga Viberg**
Designing Culturally Aware Learning Analytics for Improved Learning at Scale.

29 November 2022 **Data for Learning Journal Club meeting #2**
'The current landscape of learning analytics in higher education'.

30 November 2022 **Building with Data Hackathon**
Kick-off event in Teaching Lab.

06 December 2022 **Building with Data Hackathon**
Weekly walk-in questions hour meeting.

13 December 2022 **Organisation of Case Pitching Workshop on Data for Learning**
Planning and preperation. Discussing who to involve.

13 December 2022
Building with Data Hackathon
Weekly walk-in question hour meeting.

21 December 2022
CEL Science Speaker - Kazem Banishashem
Theory, pedagogy and learning analytics.

10 January 2023
Building with Data Hackathon
Closing meeting - Hackathon was cancelled due to decline amount of participants.

11 January 2023
CEL Science Speaker - Martin Ebner
MOOCs, Learning Analytics and OER - Why we need it for the future of higher education!

17 January 2023
Data for Learning Journal Club meeting #3
'Privacy and analytics: It's a DELICATE issue a checklist for trusted learning analytics'.

14 February 2023
Programme group meeting
Writing session: Planning and framework.

21 February 2023
Programme group meeting
Writing session: Brainstorm and action plan.

19 April 2023
Programme group meeting
Writing session: Writing on white paper.

24 April 2023
Programme group meeting
Writing session: Writing on white paper.

08 June 2023
Steering board meeting
Feedback on whitepaper 2022-2023. Looking ahead 100 days of 2023-2024.

04 July 2023
Programme group meeting
Writing session: Integrating feedback from all stakeholders.

25 July 2023
Programme group meeting
Whitepaper: Finalising content. Designing document.

1
2
3
4
5
6
7
8

100 DAYS OF DATA FOR LEARNING