AVT

Activity data for assessment and adaptivity

KS FoU–prosjekt 174018 – Læringsanalyse

Summary of SLATE Report 2019–1

Summary of SLATE Report-1 delivered to KS - June 2019

Wasson, B., Morlandstø, N.I. & Hansen, C.J.S. (2019)

The Centre for the Science of Learning & Technology (SLATE) has led the Activity Data for Assessment and Adaptivity (AVT) project. AVT was initiated by Oslo Kommune, Utdanningsetaten (Educational Authority in the Municipality of Oslo) and the project is funded by KS (Norwegian Association of Local and Regional Authorities). The AVT project has investigated the possibilities for sharing activity data between vendors who supply digital tools to Norwegian schools, in order that they can provide learning tasks/items that are better adapted to a learner's need. The work has been led by project manager Nina Morlandstø at SLATE, with a project group comprising members from SLATE, Oslo Kommune, Utdanningsetaten, and KS. The project started in August 2017 and was completed in May 2019.

SLATE Report-1:

Kontakt informasjon:
Barbara Wasson, Nina Morlandstø & Cecilie Hansen
Centre for the Science of Learning & Technology (SLATE)
Psykologisk fakultet
Universitetet i Bergen
Postboks 7807
5020 Bergen

1 AIM

The Activity Data for Assessment and Adaptivity[1] (AVT) project aimed to investigate the possibilities for the integration of activity data between vendors of digital tools in schools, in order to provide learning tasks/items that are better adapted to a learner's needs. The project had as a goal to develop a framework for learning analytics that structures the data generated by learners working with digital tools, and provides an infrastructure that handles secure data exchange between vendors, and enables the recommendation of relevant tasks/items for learners. A second goal was to gain experience and test solutions for uniform exchange, structuring, and secure sharing of data, in order to provide a foundation for future work with learning analytics in primary and lower secondary education.

Such a framework contributes to knowledge about how learning analytics can be used to identify a learner's competence level, identify learning gaps, and link to relevant learning resources, while at the same time serves as a resource for digital tool providers (e.g., EdTech vendors, Publishers) to develop high quality adaptive learning tools and resources. The framework also contributes to a discussion about how learning analytics can contribute to an increased quality of assessment work in schools. It is a goal that the framework will become a reference for both school owners and content providers throughout the country when acquiring and developing digital learning resources. The project focused on mathematics, the area of "numbers and algebra" in particular.

2 Framework for learning analytics

The Framework for Learning Analytics comprises three models: Subject Map (Fagkartet) - Integration of activity data (Integrering av aktivitetsdata) — Learning Model (Læringsmodell). The framework has been developed with input from meetings with relevant professional bodies (Norwegian Data Protection Bureau and Norwegian Competition Bureau), from research, from input from participating EdTech vendors and from a stakeholders reference group. Furthermore, the framework has been tested by selected schools in Oslo and by participating EdTech vendors. The research in the project was approved by the Norwegian Centre for Research Data (NSD).

2.1 Model 1: Subject Map (Fagkartet)

Model 1 provides an appropriate organisation of topics within a subject area and enables tagging of the topics to the competence goals in the national curriculum.

In order to carry out learning analytics on activity data, the data need to be consistent and comparable. The exercises (or items) in the respective digital tools need to be tagged with metadata from a common reference set (a common set of topics for a subject area). The project has developed a common reference set for the mathematics subject area "numbers and algebra". This structure is referred to as the "Fagkart", see fig. 1.
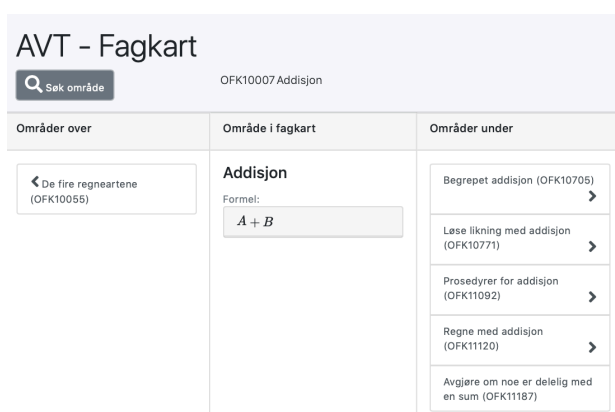

Fig.1 An area in the Fagkart

It is necessary to be able to compare pupil's data from the different digital tools in order to gain a more comprehensive overview of the pupils' activities and progression in a subject area. The Subject Map enables providers of digital tools to tag their items and tasks against a common structure of the topics in a uniform and consistent manner. Furthermore, the topics in the Subject Map are tagged against the competence goals in the national curricula (GREP). The project has demonstrated that the Subject Map can be used, and making fagkart.no openly available facilitates further quality assurance as users can navigate it and provide feedback.

---

[1] Aktivitetsdata for vurdering og tilpasning (AVT)

2.2 Model 2: Integration of Activity Data (Integrering av aktivitetsdata)

Model 2, Activity Data Integration (see fig. 2), facilitates secure sharing and integration of activity data between digital tool vendors. In particular, it provides quality assurance of the coding and decoding of raw data (i.e., the pupils' activity in the digital tools and assessment of their competence) based on national standards for the field.

Sharing of activity data has both technical and privacy challenges. In order to integrate activity data from different vendors, the data must be available in the same format. Furthermore, it is important that it is possible to integrate the activity data into a common, consistent dataset that can be used for learning analytics. This means that the data must be clearly tagged and described. Activity data must be delivered in xAPI format (standard transmission format). It is important that tasks / items are tagged against the subject map, so that this information is included in the xAPI deliveries.

A focus in the work with Model 2 has been on making sure that privacy and data integration follow national and international standards and regulations. To ensure this, the AVT-HUB (as shown in fig. 2) has been developed to enable secure access management and privacy.
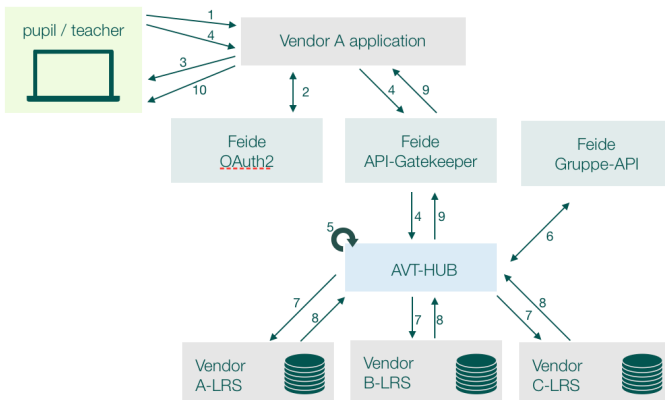

Fig. 2 Integration of activity data

2.3 Model 3: Learning Model (Læringsmodell)

Model 3, Learning Model, is a conceptual model (see fig. 3) that describes which components must be in place to: 1) identify and represent areas in the subject map where a student, or group of students, lacks competence, 2) recommend where in the subject map a single student should work, and 3) recommend the item with which a student work. To meet these requirements, the project has looked at literature on Intelligent Tutoring Systems, Recommender Systems, and Learning Analytics and concluded that Model 3 include a Learner Model, an Open Learner Model, and analysis and recommendation algorithms. The Learner model represents the student's understanding or skill related to various topics of the domain, based on the subject map. The analytics algorithm uses the activity data of a student (for example: activity, the difficulty of the activity, the amount of time it takes for a student to answer, the number and the hints used, and the number of attempts) to update the Learner Model. The recommendation algorithm can be implemented in vendor tools, or in a central solution built on a central Learner Model. Results from the recommender algorithm are visualised in an Open Learner Model, which provides interfaces for both pupils and teachers. Since the amount of data available in the project was too small, this work is unfinished and it is recommended that the work continue in the next phase of the project, AVT2. Further work is dependent upon receiving larger activity datasets from more vendors.

A simple prototype of an interface for pupils and teachers, Mitt fagkart, has been developed. Here, the pupil or teacher can get an overview of which tasks performed by the various vendors. This interface can be expanded to an implementation of an Open Learner Model in AVT2.
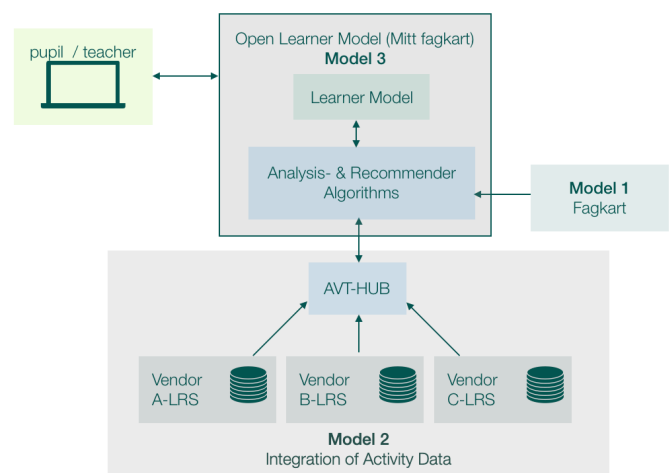

Fig.3 Conceptual model of Learning Model

3 Analysis of activity data

Activity data available in the project is a dataset of activity data from Kikora and a dataset of activity data from a standardised test, "Overgangsprøver i matematikk" for the 7th grade, for the years 2017 and 2018. Both datasets contain xAPI data provided in JSON format; the data is anonymised so that is not possible to trace back to the individual student.

Key figures from the analysis

- 2 datasets were available for analysis: Overgangsprøver (OP) and Kikora (K)
- 821 unique student ids are common for both datasets
- 58 areas in the Fagkart were tagged in the activity data: 39 (OP) og 19 (K)
- None of these 58 areas in the Fagkart are overlapping
- Average correct answers: 63% (OP) og 95,74% (K)
- Average number of available solutions used per student: 18,99%
- Average time used per item (K): 123,17 seconds

4 Analysis of the interviews

To identify opportunities and challenges with the use of learning analytics, vendors, teachers, and employees of Oslo Kommune, Utdanningsetaten[2] have been interviewed. A summary of the findings includes:

- Learning analytics is seen by the vendors as an opportunity for providing individually tailored (adaptive) learning activities where digital tools can support the teacher's teaching and assessment practices.

- The vendors do not yet offer adaptive tools, but see learning analytics as an opportunity for supporting such technology.

- To provide adaptivity, the pupil's achievement must be identified so that the tasks can be adapted to the pupil. The possibilities for identifying goal achievement are dependent on various factors such as a common taxonomy and the quality of the tool.

- The vendors describe increased opportunities for objectivity and fairness through the use of learning analytics. Such objectivity is important for summative assessment, where one can potentially reduce the uncertainty of a teachers' subjective assessment, which may be coloured by their relationship with the students. Digital solutions for summative assessment can act as a support and a supplement to the teacher's assessment.

- The tools offered by the vendors focus on assessment for learning and are not intended to be used for grading.

- Both teachers and vendors point out that the digital tools must be improved.

- The teachers find that the digital tools provide a large number of tasks for practicing. As pupils are in constant development when it comes to learning, it is difficult to know the actual learning outcomes based on the data that is collected through the digital tools.

- The teachers express a skepticism that digital tools, as they are available today, can provide them with valuable support in their assessment work. This skepticism is based on the lack of complex problem solving tasks and no identification of misconceptions in the tools, and in the large variation in the pupils using the tools. Today's tools are too simple to offer complex tasks and display various mathematical techniques. High-performing pupils require less volume training in simple techniques and should be exposed to more complex tasks, while the opposite may apply to low-performing pupils.

- Previous research on pedagogical approaches that focus on individual problem solving finds that students who struggle the most at school are the least active. It is difficult to say whether the use of individualised digital tools will produce the same result, if they also offer adaptivity to the student's level of achievement.

---

[2] Education authority of the Municipality of Oslo

- Assessment competence among the teachers is described as varying.

- Teacher's competence in understanding digital tools and their underlying data is also a challenge.

- Sharing data with other vendors is seen as challenging due to the competitive nature of the sector, as well as seeing how to use each other's data.

- It has been important for the vendors to participate in the project. It provided a platform for dialogue with other vendors and with Oslo Kommune, Utdanningsetaten, it offered an opportunity to share their expertise and experiences, and to start developing new versions of their technologies.

5 Recommendations

We recommended that the work continue in AVT2, with prioritising in the following areas.

Further development of Fagkartet

Fagkartet should be quality assured by having the vendors further test it according to its intended use. It is also important that the Fagkartet is reviewed by mathematics didactic experts before it is further developed and expanded further. The taxonomy must also be described and explained, and the tagging against national curriculum should be reviewed and updated according to the new curriculum in mathematics (Fagfornyelsen—subject renewal). Furthermore, it is recommended that the Fagkartet for mathematics should be expanded to other areas of mathematics before developing a Fagkartet for another subject area.

Integration of activity data

There have been discussions about how much mandatory data should be specified in the vendor APIs. If we require a large amount of mandatory data, will we get considerably less volume? If we open for non-mandatory data, it will make comparing data more difficult, and this has a bearing on how precise the analysis can be. In order to carry out research on learning analytics and recommendation algorithms there is a need for a larger volume of activity data that is tagged according to the xAPI specification as defined by the project. This requires having more schools participate and by having more vendors deliver activity data in xAPI format. It is further recommended that vendors make available APIs for searching metadata for items and tasks according to the revised version of the standard: Learning Technology - Metadata for learning resources NS 4180.

Further development of Mitt fagkart

We recommend that Mitt fagkart be further developed as an Open Learner Model (including analytics and recommendation algorithms). This provides a centralised dashboards for pupils, teachers, and eventually parents/guardians. Tailored dashboards should contain visualisations of aggregated data showing achievement levels for the various topics, competence gaps, and recommended items for further work. It is important that an eventual solution take into account the weighting of various sources of activity data.

Research

More knowledge is needed to be able to identify the opportunities and challenges that activity data and learning analytics will bring into schools. More research is needed on technology development, as well as the issues that have emerged about: which data, data quality, data capture, and data usage. It must be further examined which data supports formative and summative assessment processes and how these can work together. More knowledge is needed to get a clearer picture of the technology offered and used in school's today. Further clarification about the visions of the vendors and teachers and the actual opportunities that do exist is needed. It is a paradox that many digital tools are focused on individual problem solving while research shows that individual problem solving does not result in all students working more actively. Thus, more research is needed on how digital tools can contribute to more active student learning. Teachers themselves believe that their assessment competence is inadequate, and when data is analysed by digital tools, the teachers become even more uncertain about the data; thus, there is a need to increase data competence among teachers.

Other

It should be clarified which organisation(s) should have ownership of the various solutions that the project has, and will, develop, so that further development and maintenance are ensured. This applies to the Fagkartet, AVT-HUB, and Mitt fagkart.