# *Teaching with an adaptive technology: Data, acceptance and change*

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## Abstract

In this paper we present the first findings from a 4 year longitudinal study that investigates the interplay between an adaptive learning technology and educators and students in a nurse education in Denmark. With inspiration from grounded theory we analyse data from 14 hours of classroom observations supplemented by educator interviews, student surveys and mini interviews with students. In the paper we focus on the role of a new technology in the classroom: we ask how data reports from an adaptive learning technology influence educators 'preparations for classroom activities, and we ask how students' technology acceptance evolves over time. Analyzing our data we see three main themes emerge that contributes to answer the research question:

- **Interpretative inclinations:** The adaptive technology contributes to planning the lessons with a recurring inclination in practice: wrong answers lead to more educator presentations, and correct answers lead to student-centred group work during class.
- **Implicit comparisons:** The use of data reveals the educator's expectations and assumptions when she implicitly compares the data on the students with her intuition, and when she compares the technology with the physical book. The implicit comparisons make the use of data challenging for the educator.
- **Reverse adoption:** The students find it hard to grasp the intention of the adaptive technology, but they accept and learn to adapt and appreciate it over time.

In contrast to e.g. Rogers 'technology acceptance theory we find that the adaptive learning technology cannot be evaluated per se: in order to describe how a learning technology is accepted and what role it comes to play in an educational context, the parameter of time is mandatory to include in the research design.

## Keywords

Adaptive learning technology, data, teaching and learning, nurse education, learning platforms

## Introduction

When considering the interjection of new technology in a learning context, two immediate questions are often posed. First, whether the users will accept or reject the new technology and second what their reasons for doing so are. Underlying these questions are often assumptions that users 'acceptance and rejection, respectively, are expressions of a rational process that weighs pros and cons of the technology *in and of itself* or the impact the technology is perceived to have in a given context. Sidestepping the problematic idea that technological phenomena can be isolated and considered independently (Bruce, 1996), we consider a different problematic aspect of such assumptions. What if decisions to accept or reject a technology in some cases are more strongly influenced by the existing technologies at work in the context than the perceived benefits or drawbacks of the technology introduced? Or, in other words, what if technologies are accepted or rejected based on *where* they are placed in the network of technologies at work in a given context?

This article discusses preliminary findings of a four-year project following the implementation of an adaptive learning platform, Rhapsode, in nursing education. Adaptive Learning, alternatively known as personalized, responsive or predicative learning systems, is a relatively new technology in the educational field (Fitzgerald et al, 2018) based on data mining and learning analytics (Atkinson, 2015). However, the technology is also the latest embodiment of a longstanding ambition in educational thinking (Friesen, 2020) - to create a system that is able to individualise learning on the fly (Williamson, 2015) in a scalable (platform) solution (Cone, 2021). Attempts to conceptualize how to connect data with didactical decisions are prolific and many-varied (e.g. Anon; Kennedy et al, 2016; Rodríguez-Triana et al, 2015; Sergis & Sampsons, 2017; van Leeuwen, 2015; Wise, 2014). For this project a learning design was put together by a team of educational researchers working together with educators from the nursing education department, and representatives from the adaptive learning platform company. The design was shaped by the ambition to replace traditional student preparation using textbooks with preparation in Rhapsode. The hypothesis was that generating data on student preparation, understanding of the subject matter and level of confidence would be useful for a teacher preparing classes. Based on the data the teacher could make informed decisions on what emphasis to put on different problems and subject matter; make better didactical choices in teaching methods; as well as differentiate between student groups. Ultimately, the data would free up valuable time in class from having to lecture on the entire curriculum to only problematic areas.

A vital part of the design was a successful implementation of the adaptive technology in the 'educational ecology, 'i.e. a successful adoption of the learning platform as a tool for preparation on par with reading a textbook by the students coupled with a successful shift in preparation practices of teachers where data is consulted informing didactical choices. It would therefore be natural to assume that theories of technology adoption would be pivotal for understanding the implementation process. There is an extensive literature on the subject from different fields such as Information Systems, (Li, 2010), Technology Studies (Straub, 2009), IT management (Taherdoost, 2018), or across disciplines (Alexandre, Reynaud, Osiurak & Navarro, 2018). Naturally, technology acceptance and adoption theories are also found in the field of educational technology as well (Granic & Marangunic, 2019). If we consider a classic theory in technology acceptance, Rogers (1983) point to five elements that are particularly important. First of all there has to be a relative advantage in switching to the technology in question. Secondly, the solution has to be compatible with existing technology. Thirdly, the complexity of the technology has to be at an appropriate level. Fourthly, the technology has to be possible to test in advance; and finally the relative advantages of the technology have to be easy to communicate to all users.

Looking at these elements in the context of our project we find it difficult to explain the acceptance curve of the technology in the project (Authors, forthcoming). We see a movement from a very pronounced, but expected, implementation dip Fullan (2004) to a surprisingly unproblematic acceptance and use of the new technology. In the following we seek out explanations for this movement. The research question is thus:

*How do data reports from an adaptive learning technology influence educators 'preparations for classroom activities, and how do students' technology acceptance evolve over time?*

Thus, in this paper we relate to the old definition of networked learning as 'learning in which information and communications technology (ICT) is used to promote connections: between one learner and other learners, between learners and tutors, between a learning community and its resources '(Goodyear et al., 2004). However, we will focus our attention on the connections between the educator and the students. Considered as an assemblage of tools, artefacts, and infrastructure the configuration of the 'work of school' is a highly recognizable and regimented type of network in action. While being set in its ways (Cuban, 1993), there is considerable leeway for performing improvisations, work-arounds (Alter, 2014) and substitutions making the system an extremely robust network of interactions that are able to persist even when hardware breaks down (switch from slideshow to whiteboard), the teacher is sick (substitute teacher or self-study) or even if a society is suddenly shut down, as has been recently demonstrated in relation to emergency remote teaching (NLEC, 2021). Adaptive learning technologies seem in some respect to cut across existing networks; designed as closed ecosystems in themselves, as they assign fixed tasks to teachers and students in the system while leaving many infrastructural decisions to the system. Such a design threatens to impose a straitjacket on an otherwise flexible system, obliging the surrounding actors in the network to adjust around the system. However, as it is the adaptive system that is the newcomer, much of what follows can be interpreted as the existing network of interactions 'absorbing' the new system into the network. More specifically, the adaptive learning technology is recognized by the system as a form of 'homework' assigned by the teacher and performed in the system by the

students. The novel step added is access to data visualized as reports for the teacher. As such the system manages to accept the system while protecting itself at the same time.

## Method

This study draws on a qualitative longitudinal and comparative study, combining several sources of data from a total of 54 students, with a frequency of 6 visits in two nursing education classes. The duration of the study was a total of 90 days, from September 17 to December 16, 2021. The visits were distributed as three visits in cohort A, an intervention group with Rhapsode as preparation, and 3 visits in cohort B with traditional books as preparation. For cohort A, students were encouraged to prepare two days ahead of the class, so that the educator had time to look at the data and plan the class according to the needs and performance of the students.

**Table 1: Overview of data collection and sources**

| Visit no. and cohort | Content and number of Rhapsode chapters | Classroom observation | Educator debrief interview | Students group interview | Mini survey |
|---|---|---|---|---|---|
| 0a | Introduction to Rhapsode | x (online) | | | |
| 1a | Endocrinology, metabolism (5) | x | x | x | x |
| 2a | Genetics, reproduction (4) | x | x | x | x |
| 3a | Gerontology (1) | x | x | x | x |
| 1b | Endocrinology, metabolism | x | x | | x |
| 2b | Genetics, reproduction | x | x | | |
| 3b | Gerontology | x | x | | |

The strength of longitudinal qualitative research is that it allows for studying changes over time (Saldaña, 2003). As both students and the educator were new to Rhapsode, the gradual process of getting accustomed to using it in preparation for class, was carefully followed and monitored through our research design. Thus, it enabled us to make analytical deep dives into habits and understandings that develop, particularly related to how the educator interprets, plans and acts upon the data provider through student preparation in Rhapsode. In this paper, we are predominantly concerned with the classroom observations and teacher debrief interviews. The purpose of the debrief interviews were to shed light on the instructional choices and actions of the educator and how and to what extent the choices related to data and content from Rhapsode's reports.

The coding process was undertaken with inspiration from grounded theory which is a general and widespread method of analyzing especially qualitative data (Clarke & Friese, 201). Before the formulation of grounded theory, research was traditionally based on a quantitative dataset and a pre-formulated and testable hypothesis, but Glaser and Strauss (1967) showed that qualitative empirical data could also be produced and analysed systematically with a qualitative approach. Thus, grounded theory can be defined as a "theory that was derived from data, systematically gathered and analyzed through the research process. In this method, data collection, analysis, and eventual theory stand in close relationship to one another" (Corbin & Strauss, 1990, p. 12). Through this methodological approach, our purpose was to identify transversal themes and tendencies in observations and statements from the teacher in an initially broad perspective.

After data collection, all data were imported and coded in a computer-assisted qualitative data analysis software, Dedoose. Although, some research discusses whether the researcher's own analysis and interpretations are challenged when software contributes actively to pointing to links between codes and categories (Glaser, 2003), the contribution of technology can also be considered to only help the structure of data (Hesse-Biber, 2013, p. 327 et seq.). Thus, for this paper, the codes and themes were created during a coding process where themes and

codes evolved over time and called for re-coding several times. Analysis in Dedoose showed where in the data set the codes were used, and the program helped to unveil patterns and themes and to confirm or disconfirm our hypotheses that were thoroughly discussed among us. These emerging and selected themes will guide the points highlighted in the following analysis.

Below we present the emerging themes and findings we saw while analyzing our case-based datasets. As mentioned, we observed six teaching lessons (14 hours) and noted in detail the classroom activities that were taking place. Moreover, we interviewed the educator, Sarah (pseudonym) afterwards to make her elaborate on her preparation for the day's teaching activities. Sarah was not introduced to ideas or concepts of how data could inspire her teaching, and thus the study is exploratory in its nature and sheds light on how she and the students intuitively react and interpret the adaptive learning technology.

# Findings

The following findings are examined at eye-level with the participating actors. Based on our analyses, we identified three recurring phenomena and developed a concept for each that highlight the main findings:

- **Interpretative inclinations:** Rhapsode contributes to planning the lessons with a recurring inclination in practice: wrong answers lead to more educator presentations, and correct answers lead to student-centring during class.
- **Implicit comparisons:** The use of data reveals the educator's expectations and assumptions when she implicitly compares the data on the students with her intuition and when she compares the technology with the physical book. The implicit comparisons make the use of data challenging for the educator.
- **Reverse adoption:** The students find it hard to grasp the intention of the adaptive technology, but they accept and learn to appreciate it over time

### Interpretative inclinations: Mastery and lecturing

Throughout the period of observation, we identified what we refer to as the educator's 'interpretative inclinations'. This concept indicates that patterns emerge in how the educator is inclined to interpret relevant data and act upon it. Throughout all observations, when preparing for class, Sarah takes her point of departure in Rhapsode's teacher dashboard to see how the students have prepared for today's lessons. Her main focus of attention is the list of most difficult learning goals.

During preparation for the teaching in the first lessons in cohort A, Sarah sees that many of the students have struggled, and she concludes that she has to present the learning content in class because Rhapsode has not reached the goal of making the students understand the subject matter sufficiently this time. Thus, in the classroom she presents the subject matter that students had struggled with in powerpoint slides (See table 2, observation 1A and 2A). In contrast, when consulting the data for the last lesson (3A), Sarah sees that the students have a lot less problems in mastering the subject matter. Thus, the reasoning for the educator was that there was more time for group work and less need for educator presentations. In the last interview, she explains: *"Actually, a lot of the students had it under control, so there wasn't a lot for me to do concerning the "wrong answers." So, I could focus on creating assignments for group work and they could use what they had learned [in Rhapsode]*" (Interview with eucator #3A). Supporting the second approach was Sarah's assessment that the subject matter for the last lesson in Rhapsode was structured better in a way that linked the text closer to the questions: short texts followed by relevant questions.

The logic in Sarah's interpretation of data is thus to connect the students perceived mastery level with a need for lecturing. Low mastery leads to class designed around lecturing. A high level of mastery leads to a class design that allows for group work and other formats. Table 2 presents an overview of the classroom activities. When data showed Sarah that the students were struggling, she was inclined to focus the learning activities on more educator presentations and classroom discussions and fewer group work sessions and vice versa. We observed this pattern for cohort A, since in the case of cohort B there was no Rhapsode data to consult.

**Table 2: Kinds of activity during class (based on classroom observations)**

| Min. | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cohort A (Rhapsode preparation) | | | | | | | | | | | | | | |
| obs1A | | | | | | | | | | | | | | |
| obs2A | | | | | | | | | | | | | | |
| obs3A | | | | | | | | | | | | | | |
| Cohort B (Traditional book preparation) | | | | | | | | | | | | | | |
| obs1B | | | | | | | | | | | | | | |
| obs2B | | | | | | | | | | | | | | |
| obs3B | | | | | | | | | | | | | | |

**Legend:** Educator presentation Dialogue in plenum' Buzz breaks' Group work Student presentations

When we compare the design of the classroom activities for cohort A with cohort B, we find only few differences. Sarah finishes all her lessons in cohort A before she meets cohort B and the preparation of the cohort A learning activities seem to inspire the ones for cohort B. However, the reasons and the preparational experiences are very different. Whereas table 2 reveals the structure of classes and the kinds of activities initiated by Sarah, it does not tell us how Sarah prioritized different subject matter differently across cohort A and B. The inclination to look at most difficult learning goals also affords a prioritization of what content to include on her slides and the questions to ask in plenum and buzz breaks:

*"I gave them different questions this time. Last time [with Rhapsode], there was a great focus on homo- and heterozygotes, so I also asked the students about that. But for me, that was way too elaborated. They will never be required to know this in reality. So this time, I gave them more general questions."* (Interview with educator #2B).

Thus, the adaptive learning technology, from the perspective of Sarah, affords her to prioritize the learning goals they struggle with even though she professionally deems them of less relevance to their professional practice.

### Implicit comparisons: Challenging data and technology

The students 'digital footprints in the learning platform are presented in a dashboard through data reports which only the educator is able to access. The reports give insights into how much time the students have spent while preparing for class; how many times they try to answer a question before getting it right; whether they answered all questions and so on. The data is therefore a source of knowledge on students' preparation and mastery that is usually unavailable for the educator. During the first interview, Sarah says the following: *"It is a strength: I see things that I didn't expect. E.g., the function of the bile, I didn't expect it would be here [among the difficult goals]*" (Interview with educator #1A).

Based on such insights and other platform data, Sarah prepares for the next day's classroom teaching. When Sarah expresses surprise, disappointment, or when she assesses the technology or the performance of the student, we interpret these as a result of an 'implicit comparison 'with her 'normal 'expectations. For example when the content that Rhapsode presents to the students differs from what she - through exercising her professional judgement - finds important, when the students spend more or less time than she expects, or when they struggle with other objectives than she would intuitively expect. The reports and the technology thus serve as a mirror of what Sarah prioritizes and expects and creates an image of her assumptions. Such implicit comparisons are important, because they hint at the educator's normal framing of such matters as 'preparation before class. '

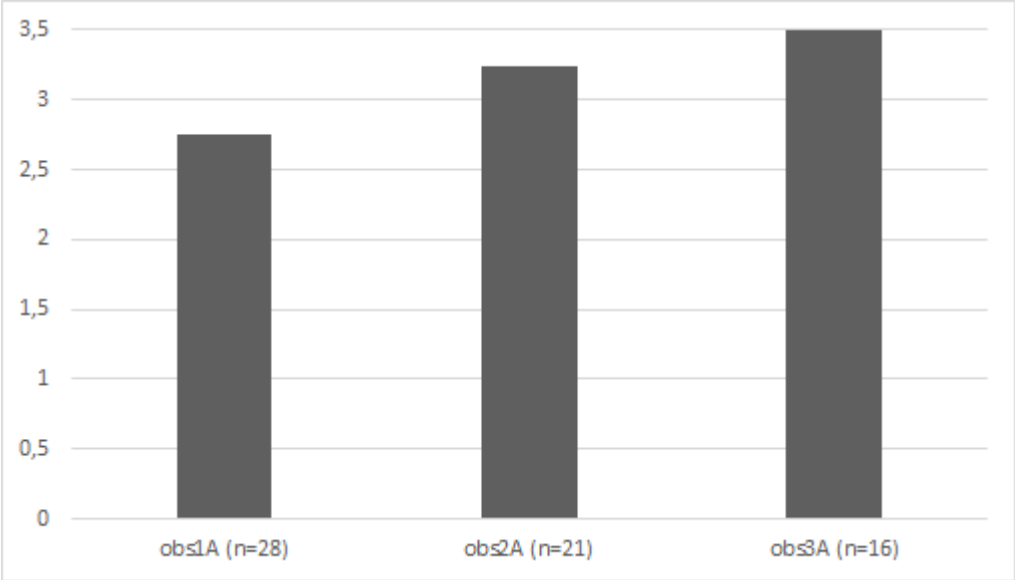
Despite the above statement that having access to data is a strength, Sarah expresses a preference for class preparation using traditional physical textbooks. The Rhapsode technology is far from perfect in her opinion

because of technical challenges for her and for the students, and because the learning content in Rhapsode is chosen by her colleagues and not by her. Moreover, as the content is transferred to the platform from textbooks that are not familiar to her, Sarah finds it challenging to navigate and get an overview of the different themes and chapters. The textbook serves as an implicit frame of reference in her judgement of the technology. When she uses a traditional book for the students 'and her own preparation, she "*feels sure that the students learn what they are supposed to learn, and I could supplement it, if I chose to do so"* (interview with educator #3A). With the physical textbook, Sarah plans the lessons based on her intuitive knowledge about what students need to learn. During the first interview concerning her teaching in cohort B, she explains: *"I know by heart what the students need to know out there [at the hospital] … whereas in Rhapsode, I had to check everything: what are their answers? What is difficult? … The preparation [this time] has been much more uncomplicated, and it has taken a lot less time. A lot less!"* (Interview with educator #3B).

### Reverse adaption: Reactions change over time

All three observations of cohort A included short interviews with students that self-identified as positive, neutral, or negative, respectively, towards the Rhapsode technology and their use of it for today's lessons. The interviews were conducted during a break. Through analysis of the interviews, a pattern emerged: Although it was the technology that was supposed to adapt to the students, a gradual reverse adaption also took place. By this we mean that the students 'understanding and appreciation of the technology also gradually changed over time. The finding is also mirrored in mini surveys conducted at the beginning of each class (see figure 1). Here, each class of students were asked to rank Rhapsode on a list of five modalities of preparation. The tendency here is also that over time, students 'tend to rate Rhapsode higher. Note the decreasing number of respondents.

**Figure 1: Students 'average rating (1-5) of Rhapsode over time in cohort A**




Description: Data are too limited for analysis of statistical significance, and thus the chart only serves to validate the qualitative findings.

At the initial interviews the students mentioned several times that they had trouble understanding how Rhapsode adapts to them (cf. Authors, forthcoming). A student put: *"Sometimes it [Rhapsode] asks you questions without presenting the text first. I had no background to answer from, and that was a bit frustrating. I did tell it [Rhapsode] that I was a beginner"* (Interview with students, #1A). Although the educator had told the students that Rhapsode's adaptive engine is designed to find out what the student knows in order to present only new learning content, the students seem to continue to expect a type of adaptivity that an educator would aim for by modifying the difficulty level.

The last interview with students (interview with students #3A) drew a very different picture compared to the former ones (interview with students #1A + #2A). First of all the interview group had a different composition as all present students self-identified as positive toward the technology. There seemed to be little to no neutral or negative experiences when the students used Rhapsode the last time. One participating student explained why

during the interview: "*It was very confusing to begin with [the first time she used Rhapsode], because it was this new way of learning, and you didn't know how to do it the first semester."* To the question of how it was different this time, she answers: *"The texts were short, and the questions were there to confirm [if you understood correctly]*". When the interviewer asked the student whether she believed that the shift in experience was due to Rhapsode or to her own way of working with it, she said: *"Well, I do think it was different this time, but I also feel that my way of working with Rhapsode is completely different now compared to the beginning of this semester."* (Interview with student #3A).

The reverse adaption not only applies to the students. Sarah explained that she had now established a practice on how to navigate, prioritize and translate the observed data from the reports into teaching: "[*This time] I spent only two or three hours on preparation, not very long*" And later she explains that the next time she is to use Rhapsode, she will need shorter time to prepare: "*I can easily make it the day before. No problem*". Moreover, she explained that the way she initially used the data, had at the end of the semester turned into her new standard practice: *"[I use them] the exact same way, yeah"* (Interview with educator, #3A)

## Discussion

Still considering the findings as they were experienced by actors involved, our immediate attention is centered on the novelty for teachers of consulting reports in their preparation work. The data reports generated from the students 'digital footprints in the digital platform were visualised as reports in an educator dashboard and showed the educator how the students had performed while preparing for today's lesson. The educator's interpretive inclinations was to consult these data and assess whether she had to supplement Rhapsode by presenting the subject matter again in class or whether she could focus on letting the students work independently in groups. Although it was time consuming and challenging to begin with, the educator eventually established her new preparation routines based on the data. However, even in the end, she found it very time consuming to prepare when she had to take the students 'data into account. Nonetheless, the data made her center the activities more on the specific group of students. The data reports can therefore be said to have had a direct impact on the educators preparations for classroom activities. However, the reports did not prescribe (cf. Donoghue et al., 2019) the classroom activities; when diving deeper into the data, the educator implicitly compared the reports with her former experiences, expectations and assumptions about the students and the subject matter. Rather than determine the educator's choices, the data served as a sounding board for the educator's preexisting ideas for classroom activities. The educator combined the subject matter presented in Rhapsode with activities chosen based on professional reflections on nurse competencies. As for the students ' technology acceptance, we saw that time also was a crucial factor. It took three months of practice for the students to adapt to the special way of preparing for class that Rhapsode demanded, but by then they saw a relevant learning outcome potential in the technology.

Returning to the question of how the adaptive learning platform was adopted, the above findings present a somewhat counter intuitive picture. Going by the students enthusiasm a rather straightforward story could be told. Starting with initial frustrations from having to figure out a new technology as well as a new preparation practice (i.e. the implementation dip as described by Fullan (2004)), the students got used to the technology during the semester and they adapted to it. In addition they had fewer wrong answers and seemed to struggle less. All of which leads to an upward trend that would explain the entirely positive students at the last interview. Seemingly the technology has been adopted with few complications. However, when we interpret the data through Rogers (1983) five elements of particular importance mentioned in the introduction, we see a different picture. Sarah actually identifies a *relative advantage* in using the Rhapsode technology, i.e. identifying troublesome subject areas. Nonetheless, she expresses a clear preference for the traditional textbook over the platform. Its perceived advantages do not outweigh the perceived disadvantages for her, due to the technology's level of complexity, the unfamiliar interface and the shifts in preparation practices for students and teachers. The students seem to presume *that* the system carries a relative advantage *qua* the system's adaptability, but their acceptance cannot be taken at face value as they seem to lack an understanding of how the system actually adapts. In other words, the relative advantage has not been communicated. The two remaining factors do not provide further clues. By the very nature of the project the technology has been possible to test in advance and given the declining level of frustrations the complexity seems to be at an appropriate level. But these seem to only provide vague reasons for students to actually adopt the system.

## Conclusion

Part of an explanation can be found in the themes that have emerged. Through the implicit comparison of the adaptive learning technology with the traditional analogue technology of a textbook, we see that Sarah is not trying to substitute the former for the latter. Rather she is evaluating its potential use as one tool among others. The technology, thus, does not need to have a relative advantage over its competitors. It only has to prove its relative usefulness, i.e. that it cannot be considered redundant compared with the existing tools. The adaptive technology thus occupies the same place as a textbook for the teacher. By the same logic we can understand the interpretative inclination. While the adaptive learning platform provides hitherto inaccessible data about student preparation for the teacher, Sarah ties in the data with didactical considerations and choices that would otherwise have been based on her experience and professional assessment of what the students need. Emphasizing how she sees the textbook as having a more optimal balance in the relative weight of choices of subject matter and at the same time taking time to address material experienced as difficult by the students is a way to stay loyal to the material not chosen by her in the adaptive platform, while maintaining a professional distance to that particular choice. Given that the student body only was exposed to the adaptive learning tool in this particular class, we might infer, in a similar manner, that it took time for the students to get used to the technology, but once habituated took to it as an alternative form of preparation. A decisive factor might be that the learning modules at the end took comparatively less time than the ones in the beginning.
In network terms the above can be stated as the network exhibiting its ability to absorb a new technology into existing patterns and schemes. The adaptive learning system is placed in the same category as textbooks, video material or in short, ressources, available for an already acknowledged activity 'homework.' As such the decision shifts from technology acceptance to technology evaluation. The technology only needs to be accepted as a viable alternative to other ressources and is subsequently placed in the network at an accepted slot, i.e. 'preparation for class.' The novelty in the availability of data for the teachers preparation, does not disturb the existing network, as the data is lumped together with and weighed against the teachers existing cache of experience and professional judgment. Overall, we found that the adaptive learning platform shows some budding promise as a tool for preparation for students and as an innovation in preparation practice for the teacher. But for this particular set of data it seems that its acceptance has more to do with how it fares as an alternative to the textbook, and the fact that it can be implemented in an educational practice in a way that only requires minor, albeit concentrated, adjustments in student and teacher practice.

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