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ICT in Business and the Public Sector

Identifying predictive KPIs and predictors for
business intelligence in the educational domain

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MASTER'S THESIS

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Abstract

In this thesis we explore the possibilities of applying predictive modeling to business intelligence in the educational domain, where we narrow the scope towards regular primary education within the Netherlands, as the needs for education can differ for different countries and also between forms of education. Using interviews with domain experts as means to initial exploration and a questionnaire as validation step, we have identified eight predictive KPIs (pKPIs) for the education domain and eleven pKPIs for the HR domain within primary education. The identified pKPIs are KPIs suitable for predictive modeling and can be regarded as dependent variables. The pKPIs for education are, as expected, domain dependent in the sense that they are most likely only relevant in (primary) education. Whereas the HR pKPIs have a more general relevance, but the motivation for their relevance can be traced back to the (primary) educational domain. Along with these pKPIs, their potential predictors (independent variables) are identified. Note that ‘potential’ entails that domain experts regarded these predictors as relevant but their association with the pKPIs is not proven within the scope of this research. We close our findings with an analysis on how these results can be transformed into actions either in practice or in further research. In this analysis the sources of data are discussed along with examples of considerations when developing predictive models for the predictors and pKPIs.

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Chapter 1

Introduction

1.1 Research problem

In the last decades Business Intelligence (BI) has seen an increase in use in a variety of fields. This includes the educational sector, where BI plays a role for different departments such as Human Resources and Education. Within BI tools the interested party is often provided with a dashboard that presents different graphical views of relevant Key Performance Indicators (KPIs). However, the information provided is limited to historical and current data, thus the information does not present future expectations. With the use of Educational Data Mining (EDM) there are numerous applications that can be used to extend BI such as predicting student performance or providing feedback for supporting constructors (Romero & Ventura, 2012). EDM can make use of different sources of data, such as e-learning platforms or student records. The volume and sources of data are dependent on the setting of education. As education can be online, in classrooms or both.

The use of EDM in education is relatively new and relevant literature often focuses on applications and methods (Romero and Ventura (2012); Algarni (2016)) rather than tangible KPIs or target predictions and the corresponding predictors. The main problem that can be identified is that there is a need for predictive modeling within educational BI tools, but no specification of what should be 'predicted'. This specification is preferably a measurable KPI which can be used to assist in decision making. One difficulty when constructing relevant predictive KPIs (pKPIs) is the lack of domain knowledge from the data miners, they often have no (or little) domain knowledge of what KPIs are relevant for the interested party. Meaning that insights from the educational field are needed to determine the goal of the data miners.

The problem that is described is especially relevant for directors and board members of foundations for primary education. The use of EDM is usually focused around students individually but does not look at the greater picture of the school (see Section 2.2). Schools and their board of directors can make use of EDM by possibly identifying under performing schools, or possibly identify where more teachers are needed in the coming years (by expecting growth) or vice versa.

1.2 Research objectives

The first objective of this thesis is to identify pKPIs using the expertise and domain knowledge of educational board members or equivalent positions, such as school directors. We look at these positions especially because they have to monitor/steer schools on an organization wide level. Whereas if we researched the viewpoints of teaching staff, who most likely look on a more individual level, the results could differ drastically. Within the scope of this thesis we define a pKPI as: “A KPI that has the purpose to serve as a target variable for data mining, specifically used for predictive modeling”. In the context of data mining, the target variable is equivalent to the dependent variable in statistics, thus the variable that is being modeled or predicted by other independent variables. In the context of this thesis predictors are equivalent to independent variables in the field of statistics.

Furthermore, this research aims to identify possible predictors of the identified pKPIs. Again by looking at the domain expertise of educational staff. Since they often have to set expectations for the future it is possible that they base their expectations on other KPIs or perhaps on intuition. The goal of identifying these possible predictors is to examine if the domain experts have a feeling of which KPIs are related to one another. Then in future research the actual relation between these pKPIs and possible predictors can be tested. Alternatively, when the relation between a possible predictor and pKPI is already tested in previous research, the predictor can be used (or not) in a data mining model for the relevant pKPI.

The last objective is to assess which pKPIs are suitable for predictive modeling and which data mining models are then suited, keeping in mind the possible predictors (if they are identified). Data comes in a variety of forms (Sagiroglu & Sinanc, 2013): structured, semi-structured, and unstructured. And within these categories there are also differences. For instance: structured data can come in tabular format with rows and columns but also in the form of time series or in JSON format. Thus the last objective aims to make suggestions for suitable data mining models with regards to the type of data.

The objectives may seem fairly simple, however due to the lack of research on relevant dependent and independent variables in education it is necessary for such a research to exist. In order to allow future research not to ‘shoot in the dark’ and hope for results, the domain expertise of the educational staff is meant to guide future research in possible suitable variables for predictive modeling. We’ll discuss more about the possibilities of future research in Section 1.6. The previous stated reasons imply that this research has an exploratory nature. Meaning that the defined research problem will be investigated and the outcome of this research will not be a direct solution to the problem.

1.3 Research questions

In order to reach the research objectives described in Section 1.2 this research aims to answer the following research question:

How can we provide primary education with pKPIs?

The term primary education can be interpreted in different manners, in the sense that it evokes the question for who the pKPIs are meant. The answer to this question is that the pKPIs are meant for the board directors of primary schools or equivalent positions. The scope of this research and thus the focus of the pKPIs is further explained in Section 1.5. In order to answer the main research question this research aims to answer the following three subquestions:

1. *What pKPIs are relevant according to domain experts of elementary school departments?*
2. *What are potential predictors of the identified pKPIs?*
3. *Can we build a predictive model based on the identified predictors and pKPIs?*

These three sub questions correspond to the three research objectives stated in Section 1.2. The first sub question aims to find out which pKPIs are regarded as relevant and important to board members or positions alike. This question aims to fulfill the first goal which was to identify pKPIs using domain expertise. The main idea of these identified pKPIs is that they can possibly be predicted by data mining models using suitable models.

The second question aims to identify the possible predictors needed to predict the pKPIs identified by the first subquestion, which is in line with the second objective of this research. In data mining models, dependent variables (pKPIs) are often predicted by the independent variables (predictors). These predictors are often closely related to the pKPIs. However, the question then remains if the data of these predictors is available or must be newly gathered in the future.

The final subquestion aims to satisfy the third objective of this research, which was to assess which pKPIs and predictors are suitable for predictive modeling. Then the question remains what type of data mining models are suited and what data sources are needed. The answer to this question comes in the form of usage recommendations for applying predictive models to the pKPIs and predictors. We shall also discuss the sources of the needed data or whether the data is not collected and needs to be collected in the future.

1.4 Method

For this research a qualitative method is used in combination with a quantitative method. The qualitative method this research uses is a semi-structured interview (Rowley, 2012), where the interviewees are presented with the same questions, but different levels of depth and adaptations of the questions. The quantitative method of this research is in the form of a questionnaire, the questionnaire is meant as a confirmatory follow-up of the interviews. The goal of the interviews is to get an initial idea of the relevant pKPIs for the researched domains; these results are then analyzed and structured. The questionnaire is then distributed to a wider audience within the same domain and is meant to confirm whether or not the found results are generalizable. More details about the method are discussed in Chapter 3.

1.5 Scope

This research focuses on pKPIs with use for primary school boards or equivalent positions. The pKPIs are not meant to be relevant for every member of educational staff such as teachers. The pKPIs this research aims to identify are meant for steering and monitoring elementary schools within the departments of Human Resources and Education. Meaning that the pKPIs are not aimed for daily operations such as teaching. As stated in Section 1.2, the viewpoints of teaching staff and board members would most likely differ in the sense that teaching staff will look at individual level and that board members will look on an organization wide level. Thus we narrow the scope to the organizational viewpoint and thus focus on board members or equivalent positions. Other research, aimed at dependent and independent variables for individual cases, such as predicting individual student performance, is needed for EDM applications on an individual level.

Furthermore, this research focuses on primary schools. Most students in the Netherlands start at elementary schools, afterwards proceed to high school until they graduate or no longer have to attend school by law, which is the case with education obligation ('leerplicht') or qualification obligation ('kwalificatieplicht') (Rijksoverheid, 2022e). After high school, students in the Netherlands can study further at the Intermediate Vocational Education, the Higher Vocational Education or a University depending on the achieved high school degree. Since these levels of education are in different phases of the student's lives, it is expected that every level has different needs and quality standards. Thus applying the findings of one educational level to other educational levels will most likely result in false implications. For this reason this research focuses on elementary schools. We also limit the scope to regular primary education, as the Netherlands has two other types of primary education (special and special primary education) which are aimed at students for whom regular primary education is not suitable. We shall elaborate more on the school system within the Netherlands in Section 2.1.1.

The final border of this research is determined by the country. As different countries have different school systems with different regulations and quality measures. Since this research is done from the Netherlands it is also the country which is chosen for which this research will be most relevant. Meaning that the research will be conducted using staff and domain experts from dutch elementary schools (See Section 3). Thus the results of this study are based on Dutch elementary schools and are not (necessarily) applicable to schools of different countries.

1.6 Academic contribution

The academic contribution of this thesis is to gain insights from the educational field and to lay a foundation for future research in EDM aimed at primary education. The aim is to identify pKPIs and possible predictors of them in order to guide future research. This thesis can help future research in the following manners:

- Inspire research to verify the possible predictors of some pKPI identified in this thesis. This would mean that a follow-up research would utilize data of possible predictor(s) and use well known statistical

tests to test whether the found predictor is statistically significant. Another approach would not only be to test significance but rather train a model that is able to capture more complex relations than simply linear relations.

- Use predictors and pKPIs and build EDM models in order to perform tasks such as predictive modeling.
- Collect data that was previously uncollected on possible predictors or pKPIs that were identified in this thesis and use them for the one of the above tasks.
- Future research could also aim to find more predictors for identified pKPIs.

1.7 Outline

In the remainder of this thesis we will firstly provide some background information about the school system in the Netherlands in Chapter 2. This chapter also includes the discussion of relevant literature. Furthermore, in Chapter 3 we explain the methodology used in this research and why this method was chosen. Then in Chapter 4 we present the results of this research. In Chapter 5 we interpret the results and answer the research questions introduced in this thesis. Finally, we close off by concluding our findings in Chapter 6.

Chapter 2

Background and relevant literature

In order to understand more about the research problem, we provide background knowledge on the topic of elementary education and the responsible foundations. Education is part of the public sector which ensures that every child within the Netherlands can have the opportunity to have free primary and secondary education (Rijksoverheid (2022k);Rijksoverheid (2022l)). This also implies that primary school foundations have to adhere to government set standards. Therefore this section provides a more deeper insight in the school system and the regulations for primary education in the Netherlands. In this section, we aim to give an explanation of primary education concepts and terminology which are useful for understanding the thoughts and insights gained from the domain experts who were interviewed for this research. As explained in Section 1.5 the focus lies on primary education within the Netherlands. Meaning that the concepts and terminology discussed in this section are explicitly about the Netherlands. After the background knowledge is discussed, the remainder of this section will focus on discussing relevant literature.

2.1 Elementary schools in the Netherlands

2.1.1 Dutch elementary school system

Within the Netherlands there are multiple types of elementary schools that children can attend (Rijksoverheid, 2022n). The first elementary school type is the public elementary school which is open for every child. This type of school does not assume any form of religion or life philosophy. The second type of elementary school assumes a certain religion or life philosophy and children are taught from this viewpoint. Furthermore, there exists elementary schools with a certain education concept. Note that the first and second elementary school types can also teach from a certain education concept. Then there are schools that offer extra activities after school such as music or sports lessons. Another type of elementary school is international oriented, these types are departments of Dutch schools and have English as their main language. However, the most important

other elementary school types (aside from regular elementary education) for the scope of this research are schools for special elementary education and schools for special education. Schools for special elementary education are organised to meet the needs of children with behavioral problems or a disability. In this form of education, children are divided into smaller groups. Schools for special education are for children that need a lot of extra support. This is the case when children have a mental disability or have serious behavioral problems. Special education is divided into four clusters (Rijksoverheid, 2022a). The first two clusters are for children that are blind, deaf or a related disability and are organized nationwide. The third and fourth cluster exists of children that have a physical handicap, mental disability and serious behavioral problems. These clusters are part of the partnership ‘suitable education’. For the scope of this research from now on we have three distinct types of elementary education: special elementary education, special education, and regular elementary education (which includes all other forms of elementary school types previously described).

In the Netherlands there is ‘suitable education’ (‘passend onderwijs’) (Rijksoverheid, 2022f), which main goal is to make sure that every child gets a place within a school that is best suited for its qualities and chances (Rijksoverheid, 2022b). This is not an elementary school type (such as discussed in the previous paragraph) but rather an initiative from the government. In order to achieve the goal of suitable education all the schools have a duty of care (‘zorgplicht’), meaning that every school is responsible for offering a suitable place in education. In order to accomplish this schools within a region or city form partnerships to make sure there is a suitable place for every child in the region (Rijksoverheid, 2022o). Every school searches, along with the parents, a suitable place in education for a child with the following options: the school itself, another regular elementary school if the initial chosen school cannot provide the necessary support, or a special education school. This is in order to prevent children from moving from school to school just because there is no suitable education in the chosen schools. The partnerships between the schools within a region offer the same basic support, the partnerships themselves decide what is included in this basic support (Rijksoverheid, 2022j). The exact offering of basic support is documented in the basic support plan of every partnership. Alongside basic support some schools offer extra support to students, which extra support is offered is documented in the school support profile.

2.1.2 Foundations

In the previous section the Dutch elementary school system on a nationwide level was discussed. However, elementary schools are not controlled by the government, only sometimes with public schools the municipality can be in control (wij-leren, 2022). Most of the time however, the role of the municipality is to assign members of the supervisory board. Whereas the daily governance may be in control of a commission or foundation. In most scenarios (especially in non-public schools) elementary schools are controlled by a foundation. In a lot of cases, a foundation is in control of multiple elementary schools. Meaning that the foundation acts as the school board for multiple schools. These school boards are watched over by the supervisory board (Oudersenonderwijs, 2022). Foundations receive their funds from the government and this amount is dependent on: the number of students and their age, education type, and the number of schools that is under control of the school board (Rijksoverheid, 2022d). Because of this there are certain laws that the foundations have to

uphold when spending the received funds (Rijksoverheid, 2022c), these laws are related to employee costs, material costs, investing and borrowing. Every year the Inspection of the Education verifies whether or not the funds are spent well (Rijksoverheid, 2022i).

2.1.3 Student results

The most important part of any school is of course teaching students and preparing them for their future in the best way they see fit. In order to measure how well the students are performing in this process of learning, their results are being measured. Schools may decide themselves how they monitor the progress of students (Onderwijsinspectie, 2022d). However, since the school year 2014/2015 schools are obligated to administer a final test and use a student tracking system. For the final test, schools can choose which one they want to administer. Schools can either administer the central final test provided by the government or choose another final test approved by the Ministry of Education, Culture and Science (Rijksoverheid, 2022h). The final test shows how well the students achieve the reference levels for Dutch language and calculation. The reference levels for Dutch language and calculation define what students should be able to master (Rijksoverheid, 2022g). These reference levels are not only for elementary education, but also for secondary education and secondary vocational education. The reference framework consists of fundamental levels (F-level) and target levels (S-level). Where F-level is considered to be the basis which as many students as possible should reach. S-level is meant for students who can handle more than F-level. For elementary education, the F-level is 1F and the S-level is 1S/2F (Onderwijsinspectie, 2022c). The Inspection of Education has certain signaling values for the percentage of students that have reached the 1F and 1S/2F levels within a certain school year. For 1F level this percentage should be 85%, meaning that 85% of students should be at this level at the end of elementary school. For 1S/2F level this percentage is dependent on the school weight. The school weight is a measure for the student population (Onderwijsinspectie, 2022a). This school weight is a value within the range of 20 to 40 and is calculated for a school as the average school weight of the last three years of that school. A low school weight denotes a less complex student population and a high school weight denotes a more complex student population. With a low school weight a school is expected to achieve higher results than a school with a higher school weight. Figure 2.1 shows the frequency distribution of the average school weight, which denotes how often each school weight occurs. The frequency distribution shows a relatively normal distribution, with an average slightly below 30.

The final test is not only meant for measuring the achieved reference levels of the school, it is also an indication for the type of secondary education that is suited for students (Onderwijsinspectie, 2022d). Students in group 8 at elementary schools receive advice from the school regarding which type of secondary education is best suited for the student (Rijksoverheid, 2022m). However, the result of the final test also comes with advice which type of secondary education is suited. If this advice is higher than the advice given by the school, then the school has to revise the advice it gave and possibly adjust it to a higher type of secondary education (it can not be adjusted to a lower type).

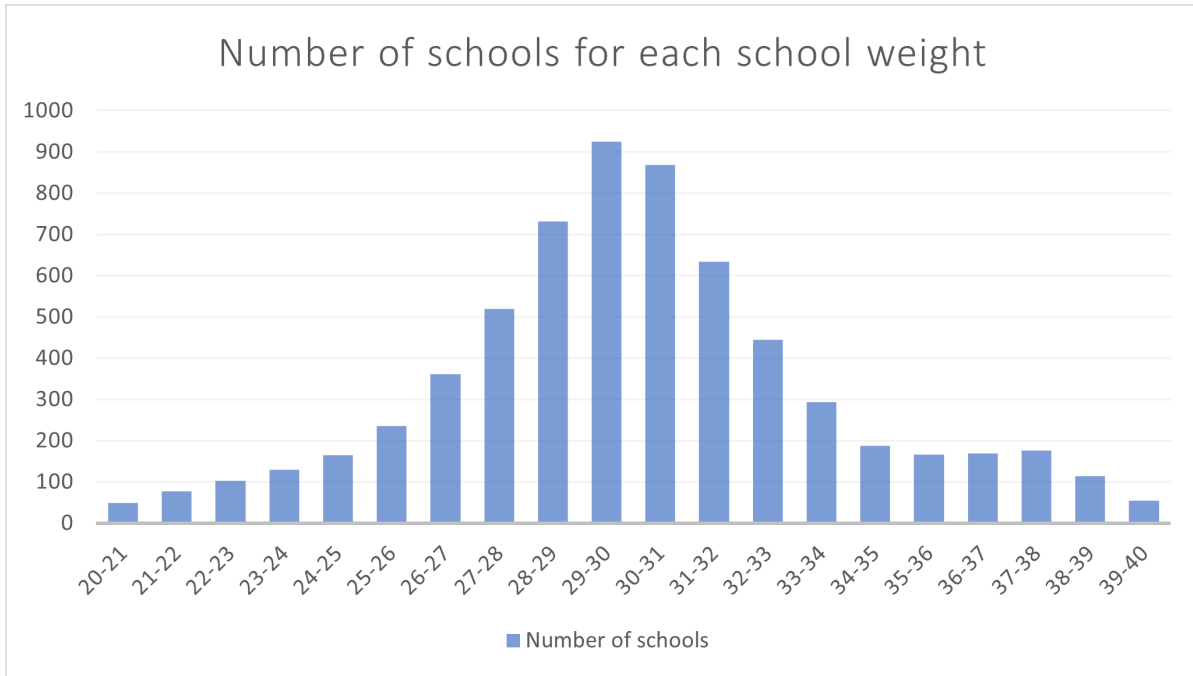


Figure 2.1: Frequency distribution of the average school weight of all schools within the Netherlands. The horizontal axis denotes the school weight and the vertical axis denotes the number of schools with this school weight (Onderwijsinspectie, 2022a)

2.2 Educational data mining and learning analytics

In Section 2.1 the aim was to supply background knowledge about primary schools in the Netherlands in order to gain a better understanding of the thoughts and insights from the domain experts who were interviewed for this research. We now aim to provide background knowledge in the fields of educational data mining (EDM) and learning analytics in order to get a better understanding of the field of research and their relationship with this study. According to Romero et al. (2010), educational data mining (EDM) is concerned with developing, researching, and applying computerized methods to detect patterns in large collections of educational data that would otherwise be hard or impossible to analyze due to the enormous volume of data within which they exist. What separates EDM from data mining is the type of data that is used, thus the field in which data mining is applied. EDM analyze data generated by any type of information system supporting learning or education (in schools, colleges, universities, and other academic or professional learning institutions providing traditional and modern forms and methods of teaching, as well as informal learning) (Romero & Ventura, 2012). What we can derive from this is that tasks of EDM are usually focused around students. Examples of common data mining tasks and their application in EDM are discussed by Algarni (2016), tasks such as predicting student educational outcomes or identifying at-risk students for dropping out.

A closely related field of EDM is learning analytics (LA) which has similar objectives as EDM. Even though there are a wide variety of definitions of LA, they all share an emphasis on converting educational

data into useful actions to foster learning (Chatti et al., 2012). Chatti et al. (2012) view LA as a Technology Enhanced Learning (TEL) research area that focuses on the development of methods for analyzing and detecting patterns within data collected from educational settings, and leverages those methods to support the learning experience. They further state the similarities of EDM and LA, which are the domain, data and process. Both fields focus on the educational domain, the data in both fields originates from educational environments, and convert this data into relevant information with the aim of improving the learning process. However, the main difference between these two fields is the focus. EDM has a more technical focus, meaning that it aims to use data mining techniques in the educational domain. Whereas LA has a more pedagogical focus, it puts analytical methods into practice for studying their actual effectiveness on the improvement of teaching and learning (Chatti et al., 2012). We can regard EDM as one of the tools in the toolbox of LA, thus making EDM a resource of the LA process.

Both the fields EDM and LA are closely related to this research. However, this study does not belong to one of these fields. Since this research does not apply data mining techniques to educational data it does not belong to the field of EDM. And since this research does not apply analytical methods to improve teaching and learning, as would be the case with LA, this research also does not belong in the field of LA. However, these fields are relevant to this research as it tries to be a starting point for both of these fields with a different viewpoint. What we mean with a different viewpoint is the target audience for whom these pKPIs are meant. Normally, with EDM and LA the focus lies on improving the learning and teaching processes and thus the target audience consists of students and teachers. However, the target audience for the pKPIs this research aims to identify are aimed at school board members or equivalent positions (see Section 1.5). These positions have very little to do with the (direct) teaching and learning. The relation from this study to the fields of EDM and LA can be found in the domain and the data. Since this study focuses on the educational domain with accompanying educational data. However, not all the data which is relevant for this study is unique to the educational domain. Such as data about the HR department of school boards which can also be found in other types of organizations. However, educational data such as data about student results or absence is unique to the educational domain. This study aims to be the starting point of these fields by identifying pKPIs such that EDM methods can be applied to the relevant pKPIs and predictors. Moreover, this research looks at educational data on an organization wide level, and these organizations aim to provide good education to their students. This can be regarded as the starting point for LA, since maybe the learning and teaching processes have a bottleneck caused by an organization wide issue rather than an issue on student or teacher level.

So in conclusion, this research does not belong to the fields of LA or EDM. But these fields are closely related to this research in terms of domain and relevant data. This study aims to be a starting point for EDM and LA to follow. EDM can be applied to the relevant pKPIs by developing predictive models. LA can be a follow-up step by looking to improve teaching and learning but by means of looking on an organization wide level.

2.3 Relevant literature

As described in Section 1.2, we define a pKPI as: “A KPI that has the purpose to serve as a target variable for data mining, specifically used for predictive modeling”. In the scope of this research we focus these pKPIs on the domains of education and HR within primary education. Although this research focuses more on the identification of these pKPIs rather than building data mining models for them, predictive models for the educational field do exist. The CBS (Centraal Bureau voor de Statistiek) has developed an educational disadvantage indicator for the primary education which was commissioned by the Dutch Ministry of Education, Culture and Science (Walhout & Scholtus, 2022). This model aims to predict student performance and tries to correct for intelligence, meaning that it looks at environmental variables of children to predict their study performance. The study shows that the education level of the parents has the strongest effect on Cito scores in group 8 out of all the researched variables. However, a limitation of this study is that the CBS has used data that is not (easily) accessible for external parties which are not hired by the government (which could supply this sensitive data). Meaning that replicating this study is difficult if not impossible. Luckily, the model yields some indirect results. Because the school weights are based on the prediction of this model of the CBS (Onderwijsinspectie, 2022b). Meaning that the school weight of a school is an indirect outcome of the model.

On top of the general use of data mining in the educational setting. This research tries to incorporate domain knowledge in the process of identifying pKPIs which are suited for (educational) data mining. Such as Sinha and Zhao (2008), who tested the difference in performance of seven data mining classification methods with and without domain knowledge incorporated. They showed that incorporating domain knowledge significantly increased performance of the classification methods. Another instance of incorporating domain knowledge in data mining is done by Lima et al. (2009). They showed how domain knowledge can be incorporated in the data mining process using a customer churn case. They used decision trees and logistic models because they were regarded as easy to understand models which perform well in similar tasks. Domain knowledge was used in two parts of the process, firstly for constructing meaningful variables. Secondly, domain knowledge was used to evaluate and adjust the constructed models. Kopanas et al. (2002) also denotes the role of domain knowledge in data preprocessing, they state that domain knowledge is used for reducing the search space.

Chapter 3

Methodology

In this section we will explain the method which was used in order to answer the research questions and complete the research objectives. Recall the main research question:

How can we provide primary education with pKPIs?

In order to answer this research question three sub questions were defined that need to be answered, they are stated in Section 1.3. In order to answer the first and second sub questions we used both a qualitative method and a quantitative method. The qualitative method we used were interviews, whose goal was to get an initial impression of relevant pKPIs and their potential predictors. More details about the conducted interviews will be described in Section 3.1. The quantitative method which was used was a questionnaire. This questionnaire contained questions about pKPIs and their potential predictors and was based on the results of the conducted interviews. More details about the questionnaire and its contents are described in Section 3.2.

For the third sub question, the answer can not be given by means of interviews or questionnaires. The answer of the third question will be a problem formulation based on the answers of the first two sub questions. This answer can also be regarded as usage recommendations for using the pKPIs and predictors in practice. For the answer of the third sub question, we will firstly analyze the results from the first two sub questions and then these pKPIs and predictors will be put in the context of data mining problems. The following aspects of the pKPIs and their potential predictors will be discussed in the answer of the third sub question:

- The types of data mining problems
- The sources of the needed data

Furthermore, suggestions about suitable predictive models will be made that correspond with the previous stated aspects that are analyzed. In order to formulate the answer of the third sub question we mostly rely on the answers of the previous sub questions and partly on literature studies. We will describe no further details about the method for answering the third sub question in this section. All of the sub questions will be

answered in Section 5.

3.1 Interviews

Rowley (2012) describes three main types of interviews: structured, unstructured and semi-structured. Structured interviews have a lot of questions with relatively short (expected) answers. The answers for this type are all asked in the same order and are all the same for every interviewee. The interview itself can be quite similar to a questionnaire. In unstructured interviews the interview is based on a number of topics, where the emphasis lies on encouraging the interviewee to talk around a certain theme. Finally, a semi-structured interview takes on a variety of different forms. This type of interview has varying numbers of questions and varying degrees of adaptation of questions.

As stated at the beginning of this chapter, the interviews were conducted in order to get an initial expression of the relevant pKPIs and their potential predictors. Meaning that the interviews have an exploratory nature. However, the desired outcome of the interviews are relevant pKPIs and potential predictors. This means that the same questions have to be asked to every interviewee, such that they can identify pKPIs, but they must have freedom to elaborate on the answers and give more in depth insights in the reasoning behind their answers. Because of this, we chose a semi-structured interview format. Since we expect longer and more in depth answers such as with unstructured interviews. However, the interviewees should be asked some specific questions such that the same type of answer can be expected from every interviewee such as with structured interviews.

3.1.1 Target interviewees

Because of the exploratory nature of the interviews, the chosen target interviewees are important since they give the initial impression of what is relevant in each researched domain. This means that domain expertise is most relevant for this phase of the research. In the context of this research we regard a domain expert as a person who has worked in a relevant educational role for multiple years. Relevant educational roles in this case are members of school boards with a role in the domain of education or HR. Recall that in Section 2.1.2 it was explained that foundations act as school boards of elementary schools. Meaning that members of school boards typically work for a foundation. Furthermore, elementary school principals are also regarded as persons who have a relevant educational role in the context of this research. This is because elementary school principals (typically educational domain experts) have a similar viewpoint as the earlier described relevant roles. Since principals have to steer a school with the same goals and ambitions in mind as the school board. This viewpoint is different from, e.g., teachers, which have more goals on a student level rather than a school level.

3.1.2 Interview design

With the desired outcome in mind, the interviews were designed in such a way that they were structured but allowed for adaptations of questions. The interview also allowed more in depth going questions which were undefined before the interview. The interviews started with more formal questions to define the profile of the interviewee. Such as questions about their job title, domain of expertise (HR or education) and what type of primary education the foundation they worked for primarily supplied. Recall that there are three main types of primary education as described in Section 2.1.1. And since interviewees can work for foundations which have multiple elementary schools, it is relevant to ask the type of schools they primarily work with. This is because this research focuses on regular primary education as described in Section 1.5. If the target interviewee was an elementary school principal, it was asked what type of school the interviewee was working for. In the remainder of the interviews the interviewees were asked which KPIs they thought were most relevant for their domain of expertise and were asked to elaborate on them. This elaboration was guided by the interviewer and topics for each KPI included:

- Explanation: What is exactly measured with this KPI
- Purpose: Why is this KPI relevant
- Priority: Which priority (relative to other KPIs) did the interviewee give this KPI
- Need for prediction: Was there a need for this KPI to have a prediction or other form of expectation for the future
- Future expectation: Did the interviewee have an idea how this KPI would develop in the future
- Predictors: If the interviewee had a future expectation then the question was on what this expectation was based.
- Level of confidence: If the interviewee had an idea for the future value of this KPI then the question was how confident they in general were about this prediction

The last four of these topics are relevant for the predictive task of the KPI, thus transforming the KPI into a pKPI. Moreover, a method that was used in certain interviews was the Goal Question Metric approach (GQM) as described by Basili et al. (1994). This method was used whenever it was found that interviewees got stuck and could not think about KPIs out of themselves anymore. The GQM approach was used as a top-down approach and was applied by firstly asking the interviewees which goal their foundation (or they) had in general for their schools. Then it was asked which questions needed to be answered in order to achieve this goal. Then based on these questions, KPIs were identified that were regarded as relevant. It is important to note that this method was used only in aid of the interviewee and thus not every interview made use of this method. Since it was not applicable in every conducted interview.

3.2 Questionnaire

As stated in the beginning of this chapter, the questionnaire served as the quantitative method for answering the first two sub research questions. The purpose of the questionnaire was to validate the results of the interviews. This means that the questionnaire validates whether or not the results of the interviews are generalizable. Two steps were taken in order to achieve this goal:

1. Design the questionnaire
2. Get responses from target audience

For the first step, the design of the questionnaire, the results of the interviews were used. The results of the interviews are described in Section 4.1. The results of the individual interviews were aggregated and from these aggregated results the questionnaire questions were formed. More details about the questionnaire questions are stated in Section 3.2.1.

For the second step of the questionnaire, response was needed from the target audience. The target audience for the questionnaire was the same as for the interviews as described in Section 3.1.1. In order to generate responses from the target audience multiple channels were used. The first channel which was used to generate responses was social media. The second channel was direct e-mailing to candidates that fit the profile of the target audience.

3.2.1 Questionnaire questions

As previously stated, the questions of the questionnaire were based on the results of the interview. The questions which were presented to a respondent were determined by their domain of expertise. If the domain of expertise was education, then the respondent was presented with questions about KPIs relevant to education. The same was done for the HR domain. The format of the questionnaire was asking several questions about a certain KPI. For the education domain there were eight identified KPIs and for the HR domain there were eleven KPIs. Meaning that respondents from the education domain were presented with questions about a KPI eight times. And respondents from the HR domain were presented with questions about a KPI eleven times. The questions about a KPI all had the following format:

- A question about which metrics were suitable for the KPI
- The reason why the KPI was monitored (if applicable)
- The relevance of the KPI expressed on a scale from 1-5
- The question whether a prediction of the KPI was desired
- The question whether a prediction of the KPI was already made by the respondent. If the answer to this question was 'yes' then the following questions were also asked:

- On what this prediction was based (potential predictor)
- The confidence the respondent had in the prediction that was made

The exact questions which were used in the questionnaire can be found in Appendix A. Note that for some KPIs not all the attributes (see Section 4.1) could be collected which were relevant for the questionnaire questions. For these ‘gaps’ the questionnaire answer possibilities are derived from previous similar answers and from the context.

Chapter 4

Results

In this section the results from the interviews and questionnaire explained in Section 3 are presented. The results will have a brief discussion but a more in depth analysis of the results with regard to the research questions is stated in Chapter 5. In Section 4.1 we will firstly describe the final formatting of the identified KPIs. After that, a summary of the findings will be given.

4.1 Interview results

In total eight interviews were conducted with domain experts. From these eight interviewees there were four interviewees who are from the education domain, three from the HR domain and one interviewee was from both domains. However, some interviewees discussed KPIs that did not fit within their domain of expertise but rather the other domain. All KPIs which were identified by the interviewees are aggregated and formatted in Appendix B. This means that for each KPI the desired attributes were collected. The desired attributes consist of the relevant topics described in Section 3.1.2 and other relevant information of the KPI. All of the attributes used to aggregate and format the identified KPIs are described below:

- KPI: Name of the KPI.
- Domain: The domain for which this KPI is most relevant (Education or HR).
- Number of interviewees: The number of interviewees which discussed this KPI briefly or in depth.
- Explanation: What is meant with this KPI. (open)
- Metrics: With which metrics can this KPI be measured. (open)
- Purpose: The reason as to why interviewees think this KPI is relevant. (open)
- Predictor of: Which other KPIs could potentially be predicted with this KPI. (open)

- Need for forecast: Was there a need for this KPI to have a prediction or other form of expectation for the future. (closed)
- Interviewee forecast: Did the interviewees have an idea about how this KPI would develop in the future. (closed)
- Potential predictors: If the interviewees had a future expectation for this KPI then on what was this expectation based. (open)
- Confidence in prediction: If the interviewees had an idea for the future value of this KPI then how confident were they about this prediction. (closed, range from low to high)
- Priority: Which priority (relative to other KPIs) did the interviewees give this KPI. (closed, range from low to high)

Some of these attributes are labeled ‘open’ or ‘closed’. An open attribute means that the interviewee could supply an open answer. Thus for KPIs which were discussed by more than one interviewee all of the given answers are stated in the aggregated results. If the same open answer was given by more than one interviewee then this answer is only stated once. A closed attribute means that the answer was either binary (yes or no) or within a range (low to high). For these answers a number can be displayed between brackets after the answer in the aggregated results. This number indicates how many interviewees gave this answer if more than one interviewee discussed the KPI. The semi-structured interview design, as discussed in Section 3.1, allowed for varying levels of depth for each KPI and interviewee. Because of this, some KPIs have missing attributes. Another reason for missing attributes is because interviewees simply did not have an answer. Such as for the ‘interviewee forecast’ attribute, if the answer from an interviewee was ‘no’ then the attributes ‘potential predictors’ and ‘confidence in prediction’ would be missing.

4.1.1 Interview results summary

The interview results which are presented in Appendix B will be summarized in this section. All of the KPIs with their corresponding metrics and predictors which were identified for the Education domain are stated in Table 4.1. The identified KPIs and their corresponding metrics and predictors for the HR domain are stated in Table 4.2.

The KPIs identified for the educational domain are quite domain dependent as could be expected. For example, the KPI ‘study results’ could not be generalizable to other non-education industries, because it would not be relevant if applicable at all. In contrast, the KPIs identified for the HR domain could be transferred more easily to other industries. However, the purpose and reasoning for some of the KPIs in the HR domain is also industry dependent. For instance, ‘absenteeism’ has multiple purposes. One of the reasons for looking at this KPI is that there is a need for a substitute teacher if one of the teachers is not available. In other industries a sick day for an employee has other forms of consequences, but for this industry it is desired to have a teacher in front of a class because otherwise the students risk a learning disadvantage if there is no

teacher available. Another example finds itself in the KPI ‘employee satisfaction / wellbeing’. For this KPI it was expected that it has consequences for the student results. Meaning that some of the interviewees expect that if there is a low employee satisfaction then it is possible that the student results may decline because of that.

The second most important findings from the interviews are the potential predictors of the identified KPIs. More context, such as reasoning, about these predictors can be found in Appendix B. A KPI can be measured in multiple ways and these are stated in the ‘Metrics’ column of both Table 4.1 and 4.2. Since the results are aggregated it is possible for a KPI to have multiple metrics each supplied by a different interviewee. Therefore in some cases, each metric can have its own potential predictors, depending on which metric the interviewee discussed. More context for the metrics is stated in Appendix B where it is also indicated which predictor belongs to which metric if applicable. In Table 4.1 and 4.2 all of the predictors available are stated without context and reasoning. Each predictor in these tables can come from the ‘predictor of’ or ‘potential predictors’ attribute of the aggregated results in Appendix B. However, some values that occur in the ‘predictor of’ or ‘potential predictors’ attributes in the aggregated results are left out of the tables. One of these values is ‘general education quality’ which was filled in multiple times as value for the ‘predictor of’ attribute. The reason for this is because ‘general education quality’ is no identified KPI that can be predicted in the scope of this research. General education quality could imply the study results but this was not explicitly stated by the interviewees. Another example is the ‘actions that are taken’ value for the ‘potential predictors’ attribute. This value was stated by an interviewee however it is not a general predictor but rather a consequence of an action, so it was not regarded as a predictor in the tables.

KPI name	Metrics	Predictors
Student numbers	<ul style="list-style-type: none"> · Total number of current students · Total numbers for interim inflow and outflow · Ratio of students in the lower classes/upper classes · Market share measured in students numbers. 	<ul style="list-style-type: none"> · Forecast by municipality or third party · Expected outflow · Historical data (of all metrics) · Market share · Demographic developments · External factors such as new neighborhoods · Estimation of school principle · Feeling
Geographical distribution	<ul style="list-style-type: none"> · A map showing where students live in the local area 	<ul style="list-style-type: none"> · External factors such as new neighborhoods
Student satisfaction / wellbeing	<ul style="list-style-type: none"> · Survey 	<ul style="list-style-type: none"> · Absence

Absence	· Average frequency of absence within a school	-
References for special education	· Total number of references to special education for a school	· Historical data
Revised advices	· Total number of advices that have been revised for a certain year	-
Status of secondary education	· Percentage of students that are on the high school level of the advice they received for secondary education, also these percentages for students that are under or above the level of their advice	· School weight
Study results	· The percentage of students that are on 1F and on 1s/2f level · The scores of the students for each subject · Level values · Intermediate test results and reference levels	· Student wellbeing · Reference levels of group 6/7 · Employee happiness

Table 4.1: The identified KPIs and predictors for the education domain.

KPI name	Metrics	Predictors
Absenteeism	· Duration · Frequency · Percentage	· Historical data · External factors · Feeling · Time of year
Labor costs	· Statistical measures for cost of labor (Such as average, minimum and maximum) · Difference between budgeted costs and actual costs	-
Available FTE	· Total amount of FTE · Total amount of staff · Number of teachers per student · Average group size per school	· Student numbers · External factors such as teacher shortage

	<ul style="list-style-type: none"> · Size of FTE with respect to a team · Size of employment 	
Students on teacher education	-	-
Employee satisfaction / wellbeing	<ul style="list-style-type: none"> · Average employee satisfaction researches per teacher · Results quality survey · eNPS 	<ul style="list-style-type: none"> · Historical data · Staff turnover
Staff division	<ul style="list-style-type: none"> · Staff division based on: age, man/woman ratio, function(group), teaching specialism 	<ul style="list-style-type: none"> · Economical status of a country
Staff turnover, inflow/outflow	<ul style="list-style-type: none"> · Total number of new employees that are hired · Total number of employees that have left · Reasons for leave · Staff turnover · Amount of staff that leaves within one or two years 	<ul style="list-style-type: none"> · Historical data · External factors such as corona and teacher shortage · Feeling · Employee further training · Legal retirement age · Benchmarknumbers
Function throughput	<ul style="list-style-type: none"> · The percentage of staff that goes from OOP ('onderwijs ondersteunend personeel') to OP ('onderwijsgevend personeel') 	<ul style="list-style-type: none"> · Quality of leadership
Workload	-	<ul style="list-style-type: none"> · Student numbers
Further training	<ul style="list-style-type: none"> · Time spent on further training · Percentage of salary costs spent on training 	-
Side inflow	<ul style="list-style-type: none"> · Total number of side inflow that stays to work after education · Percentage of side inflow that stays to work after education 	-

Table 4.2: The identified KPIs and predictors for the HR domain.

4.2 Questionnaire results

All of the results for the questionnaire are presented in Appendix C. For every question the answers that were given are displayed, both for the closed and open questions. For every answer the number between brackets indicates how many respondents selected this answer. If an answer possibility was stated in Appendix A (the questionnaire questions) but not in Appendix C, then this means that none of the respondents selected this answer. In total five respondents filled in the questionnaire, from which four were educational domain experts and one respondent was a HR domain expert. As stated in Chapter 3, the questionnaire served as a validation step. The main findings from the questionnaire are indications of importance for the following aspects of each pKPI:

- The desired metrics
- The relevance
- The need for a predictive model
- Verification of potential predictors

The results from the closed answers supplied new insights. Through the answers some of the metrics can be prioritized where metrics that were highly in demand receive higher priority. Whereas metrics that received lower demand can be prioritized lower or can even be regarded as undesired. The same can be done for the verification of the potential predictors, where predictors which were indicated by more respondents can be seen as the predictors with most likely the strongest association with the pKPI. An example of this can be found for the pKPI student numbers, where ‘demographic developments’ was selected by three respondents as potential predictor for this pKPI. Meaning that this predictor should be researched when constructing a predictive model because it was selected by most respondents as a predictor for this pKPI. The questionnaire also allowed for open answers, but this option was only used on a few occasions. Which resulted in no new valuable insights from the open answers.

Chapter 5

Discussion

In this chapter the results from this research will be discussed in depth. This is done by first answering the sub research questions in Section 5.1. The first and second sub research questions will be answered with the help of the results of the interviews and questionnaire which were presented in Chapter 4. The answer to the third sub research question will be in the form of an analysis when applying the gained insights into practice as described in Chapter 3. After the sub research questions are answered, the limitations of this research are discussed in Section 5.2. Furthermore, some recommendations are given with regards to converting the findings of this research into actions. We close this chapter off by discussing relevant ideas for future research.

5.1 Answering the sub research questions

5.1.1 First sub research question

The first sub research question was formulated as:

What pKPIs are relevant according to domain experts of elementary school departments?

This question had an exploratory nature for this thesis. The goal this research hoped to reach by searching for an answer to this question was to get an initial impression of the desired (p)KPIs. This question was answered by conducting interviews and validating them through a questionnaire. We have identified eight KPIs for the educational domain and eleven KPIs for the HR domain. The identified KPIs consist of multiple attributes as explained in Section 4.1 in order to provide context to them. Some of these attributes are relevant for the predictive nature of the KPIs, thus transforming the KPIs into pKPIs. However, for some KPIs there existed no need from the domain experts for applying predictive modeling to them. For other KPIs there existed a need to have them predicted but the domain experts did not indicate that they had an idea on what this prediction could be based. All of the KPIs and their attributes are stated in Appendix B. The questionnaire served as a validation step for the identification of the pKPIs, their metrics, purpose and

other aspects. The results of the questionnaire are stated in Appendix C, using these results the relevant aspects of the pKPIs can be prioritized. Such as the metrics of the pKPIs, some metrics for a pKPI can be regarded as more valuable than others using the majority vote of the questionnaire results. Using this method, it is also possible to discard certain metrics if they received little to no attention by the respondents.

5.1.2 Second sub research question

The second sub research question was stated as:

What are potential predictors of the identified pKPIs?

This question, just like the first sub research question, had an exploratory nature to it. It can be regarded as the follow-up question of the first question. Meaning that if there was a (need for) prediction for a certain KPI, it was explored on what this prediction could then be based. The answer lies in the predictors that the domain experts could identify. A predictor in this case can be regarded as the independent variable and the corresponding pKPI can be regarded as the dependent variable. The goal this research hoped to achieve by answering this question was to identify relevant predictors for the pKPIs by exploiting domain knowledge. Since often it is the case that data scientists, the people responsible for applications such as predictive modeling, lack the domain knowledge for identifying possible (previously unidentified) predictors for the pKPIs. This is often the case when potential predictors are not part of an available dataset (otherwise predictors could be identified by data preprocessing). On the other hand, the people that possess the domain knowledge needed to identify these pKPIs often lack the knowledge to apply predictive modeling techniques. The identified predictors for each pKPI are presented as one of the attributes in Appendix B. One example of a pKPI with its potential predictors is displayed in Figure 5.1. In the figure the pKPI ‘Study results’ and the three predictors which resulted from the interviews are graphically displayed.

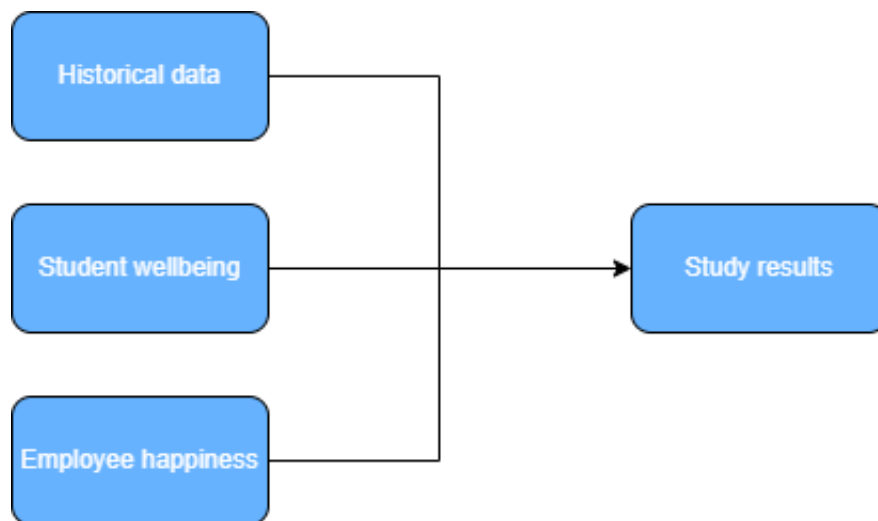


Figure 5.1: Graphical representation of the KPI study results with potential predictors identified by interviews.

The predictor ‘Historical data’ is a general predictor and occurs for multiple pKPIs. With this predictor, the historical values of the pKPI ‘Study results’ are meant. Meaning that one of the possible predictors of this pKPI could be the previous values of the pKPI itself. Furthermore, this predictor is the only predictor of study results according to the ‘potential predictors’ attribute in Appendix B. However, the predictors ‘Student wellbeing’ and ‘Employee happiness’ are identified predictors for the pKPI as well. This is because both of these predictors are also identified as KPIs in Appendix B. Both of these KPIs have ‘Student results’ as value for their ‘predictor of’ attribute. These predictors are purposely not filled in for the ‘potential predictors’ attribute for study results. This is because interviewees who discussed study results as KPI did not explicitly mention these two predictors as predictors for study results. However, the interviewees who discussed the KPIs ‘Student wellbeing’ and ‘Employee happiness’ did mention that they could be predictors of student results. Thus for these KPIs the KPI student results was regarded as value for the attribute ‘predictor of’.

Other noticeable predictors that were stated by domain experts were the predictors ‘feeling’ and ‘external factors’. With the predictor ‘feeling’ it is often meant that they had some sort of intuition for how a certain pKPI was going to develop in the future. With the predictor ‘external factors’ it was sometimes made clear what this external factor was (such as the teacher shortage or corona) and other times it was not made clear and was again more of an intuition. What can be observed from this is that the domain experts wanted to express that a future prediction should account for some noise and should not be entirely based on predictors. Therefore it is recommended to use predictive models as additional information sources and it should be noted that these models are never perfect and external factors are not (often) accounted for in these models.

Again, the questionnaire served as a validation step for the identified predictors. Where the majority vote can again validate whether or not multiple domain experts have the same feeling about these predictors. Thus predictors that were indicated by more respondents can be regarded as most likely to have an association with a pKPI. Note that this association is a feeling by domain experts and other research needs to verify whether or not there is a real association between the predictors and the pKPIs.

5.1.3 Third sub research question

The third sub research was stated as:

Can we build a predictive model based on the identified predictors and pKPIs?

The answer to this question could not be given by the interview and questionnaire results. The answer to this question is an analysis of applying the knowledge obtained by the answers of the first two sub questions and translating it into a data mining problem. As described in Chapter 2, the field of EDM is closely related to this thesis. Within EDM, the goal is to apply data mining techniques to educational data. Algarni (2016) classifies the field of EDM in five categories: prediction, clustering, relationship mining, distillation of data for human judgment and discovery with models. Within the context of this research the most interesting of these five categories is prediction. However, distillation of data for human judgment and relationship mining are also relevant applications. Prediction is the most relevant category of these five because of the predictive nature of the pKPIs that are researched. We will discuss more about specific predictive models suitable

for the identified pKPIs and predictors in Section 5.1.3. Distillation of data for human judgment is also a relevant application for the identified pKPIs and predictors because it aims to make data understandable (Algarni, 2016). As stated in Section 1.5, the identified pKPIs are aimed at primary school boards. Thus another application could be to communicate these pKPIs more clearly. However, discussing applications for this is beyond the scope of this research. Relationship mining is another potentially useful application for the identified pKPIs and their predictors. Relationship mining aims to find relationships between variables in data sets with a large number of variables (Algarni, 2016). This application could be used in addition to this research to find more relevant predictors for the identified pKPIs. However, the application of relationship mining is beyond the scope of this research and will not be discussed further.

In order to transform the findings of this research into a data mining problem, the remainder of this answer will focus on analyzing different aspects of predictive modeling. Firstly, the sources needed for the required data are discussed. After that, predictive modeling problems and techniques are explored. Finally, an example case is discussed to put the aspects into context. With the analysis of these two aspects of data mining problems, the findings of this research can be more easily converted into actionable applications.

Data sources

The pKPIs and predictors that are identified are of different kinds, some are numeric and others are categorical. But the data types themselves are not especially relevant to analyze since most of the data types are suitable for predictive modeling. However, the source of the data is relevant in order to transform the results into actions. If an organization wants to deploy a standard predictive model to its customers then for every organization the same data must be available for the predictive model to work. Another scenario is that the organization deploys custom made models to its customers.

Consider the first scenario, where an organization wants to deploy a standard pre-built model to its customers. The relevant customers are likely to be organizations such as primary school foundations (with respect to the scope of this research). For some data it can be assumed that the customer has it available, data such as the student numbers. This data has to be available for administrative purposes. The only challenge for this data source is that different organizations will probably have different systems for storing this data. Meaning that the data needs to be made available by the customer and can be in different formats. Thus the data needs to be transformed before it can be used by the model. Other data that can be made available for a standard model is publicly available data, such as the data from the Inspection of Education for the KPI ‘study results’ (Onderwijsinspectie, 2022c).

However, one problem that is faced with standard models is abstract data that is difficult to measure. KPIs such as employee wellbeing can be measured in different manners or measuring units. Since a pre-built model needs the same type of data for a variable it is difficult to use employee wellbeing as a variable at all because of the aforementioned reason. This introduces the second scenario, where customers receive custom predictive models. This means that the predictive model must be built and validated for each customer before it can be deployed. One major downside of this solution is that it contains only the data of the customer

and thus less data than when a standard model is used to train the model. This could result in a model that performs not as well as expected. A common problem is overfitting when having little data available. Meaning that the resulting model does not generalize well.

So far we have discussed data that is available through the customers and publicly. Where problems may occur when data is measured in different manners. But there is also a scenario where data is missing. Assume that it is statistically verified that employee happiness has an impact on study results, as was identified by this research. Meaning that employee happiness could be used as a predictor for a custom model for predicting study results. However, customers might not have this data collected but still want a predictive model to use this predictor. Then this customer needs to collect this data in order to make a deployable model. It is thus recommended that it is verified with the customer that the required data is available as early as possible. If the required data is not available then two options remain, the data has to be collected or the required data can not be used. If the required data can not be used then the performance of the model might be lower than similar models which did use the required data.

In conclusion, the data that can be used for predictive models can come from the customer or from public sources. Especially in primary education, public data can be of great value and can make models more generalizable. In cases where part of the desired data is not available there are two options: collect the data or build a model without it. The downside of collecting the data is that it might take a lot of time, effort and costs. But the performance of the model might improve. Meaning that each customer must consider whether the potential improvement of the model is worth the effort. The option of building the model without the desired missing data has as downside that it might result in lower performance.

Predictive models

As stated by Algarni (2016), there are three general types of predictions: regression, classification and density estimation. For the scope of this research only regression and classification are considered. Classification predicts a binary or categorical variable, whereas regression predicts a continuous variable. Meaning that every identified pKPI needs to be transformed into a regression or classification problem. This may sound trivial, but the right problem formulation is of great importance. To make this more clear the pKPI 'student numbers' is used as an example. For this pKPI, it can immediately be transformed into a regression problem. For this regression problem the desired outcome is the expected number of students for the next school year on certain dates (such as the reference date). This is a regression problem because the outcome is a number. However, this pKPI can also be transformed into a classification problem. The outcome can be a binary variable for the student numbers: are the student numbers going to be higher or lower for some date the next year? It might sound undesired, but perhaps a binary classification model is more accurate than the regression model. Also the needs of the customer and end-user must be kept in mind when formulating this problem. For instance, study results were regarded as important because primary schools receive fundings based on the number of students on the reference dates. With this argument it is likely that a regression model is more suited because then the exact funds (based on the outcome of the model) can be calculated. In scenarios such

as these it is especially important to present the expected margin of error to the customer. Because then the margin of error can be used in the calculation of the funds. For both regression and classification models there exist a wide range of choices and common practice is to try multiple before deciding which model will be trained for which task. In the following paragraphs some examples will be discussed.

Perhaps the best known regression model is linear regression. With linear regression a mapping is made from input variables (predictors) to output variables (pKPI) using coefficients. A great advantage of this model is that it is transparent, through the coefficients of the variables it is made clear how much each variable contributes to the outcome. Thus it is made clear which predictors are more strongly weighted than others in the model. A disadvantage of this model is that it assumes a linear association between the input and output variables. In order to use linear regression all of the variables need a numerical value, thus also the categorical values. For categorical values it is common practice to use a form of coding to transform the categorical values into numerical values. Another predictor which was identified multiple times was 'historical data', meaning the same variable as the outcome variable (pKPI) but then for previous years. This is a form of time series data, where a variable is measured over the course of time. This variable can also be transformed into a feature, such as the feature 'the average difference in student numbers between years for the last four years' for the pKPI student numbers. With such a transformation, the time series data is transformed into a numerical feature that can be used in linear regression.

A well known classification model is K-nearest neighbors, where outcomes are determined based on the K nearest neighbors in the input training data space. For example, the goal is to classify students as 'on track' or 'not on track' for the pKPI 'status of secondary education'. Where the label denotes whether or not a student is on the expected level in secondary education. Then based on records of the predictors and labels of previous students a classification is made whether or not a new student is on track or not. An advantage of this model is that it can be visualized and it can be detected whether there is a clear distinction between the groups in the input space.

Time series data was earlier discussed, where it was transformed into a feature and the time series aspect was lost in transformation. However, a predictive model can be applied to a pKPI solely based on the historical values of the pKPI. Such as Autoregressive Integrated Moving Average (ARIMA) models, which bases future predictions on previous observations. It is important to know that even without predictors, a predictive model could still be applied to a pKPI. A downside of this approach is that it assumes that there is a connection between the current value of the pKPI and the past values. Unlike with other models, which assume connections between other variables and the pKPI.

No recommendations can be made about which particular models are best suited for which pKPIs and its predictors. It is most important that the problem formulation (classification or regression) is well thought of for each pKPI. After the correct problem formulation, the data needs to be transformed and multiple models should be trained and compared using suitable metrics. In this section some examples were given using models and identified pKPI's. These examples were meant to show the considerations that could be made in the process of developing predictive models.

Example use case

In order to provide a more elaborate example of converting the results from this thesis into practice let us first consider the process of knowledge discovery as described by Nisbet et al. (2018). The process of knowledge discovery is graphically displayed in Figure 5.2 and is a sub process of the data science process.

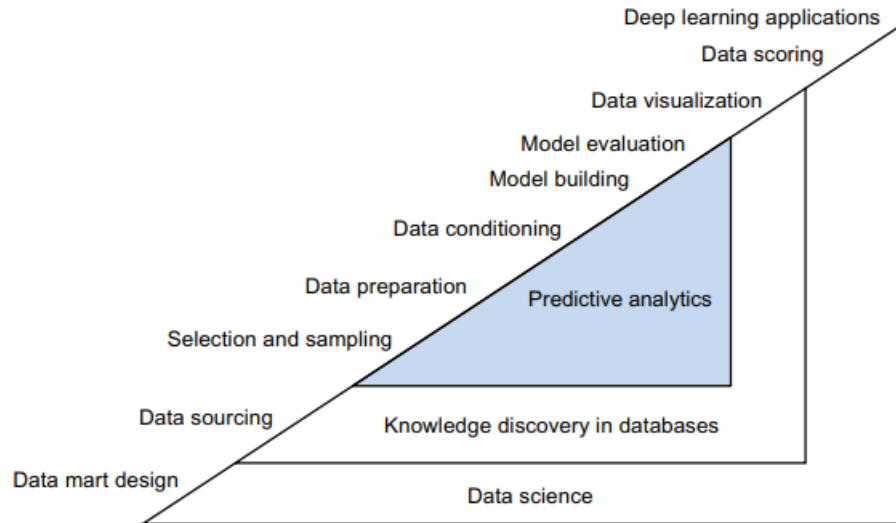


Figure 5.2: Data science process as presented by Nisbet et al. (2018).

Consider the task of predicting student numbers, which is defined as a regression problem. For this case we assume that we have to make a custom model for a primary education foundation with plenty of data available. Considerations for the relevant steps, with regard to this thesis, from the process of knowledge discovery are described below:

- **Data sourcing:** As described earlier, the data can come from the foundation itself and we can also use public sources. It is important to use as much available data as possible. For the task of predicting student numbers it is important to include public sources if available, since demographic developments was identified as potential predictor. Primary education foundations will typically not have data such as this at their disposal but municipalities or the government may have this.
- **Data preparation:** This step focuses on preparing the data for the model building step. One of the predictors of student numbers was historical data, which could be modelled as features or as times series data. In this step it is important to transform the available data in every form that is relevant. In the student number case this would be to transform the data in both features and time series data.
- **Model building:** As stated earlier, there exist a wide variety of regression models. In this step it is important to test multiple models and choose the best one based on a well chosen metric. An important aspect in this step is transparency, if varying models perform the same then the most transparent model

could be chosen because it is better to understand and communicate. If the less transparent models perform much better in terms of the chosen metric then a consideration should be made on what is more valuable for the customer. In the case of the student numbers, it may be desired to have a more transparent model because then it can be explained how the model makes its predictions. Probably a lot of stakeholders are involved which may request a justification for the predicted numbers. In this case the working of the transparent model can be explained.

If the aforementioned steps were applied on the KPI study results and its predictors, the first step is to gather the data for the KPI and each predictor. Thus gathering data for study results (including historical data), student wellbeing and employee happiness. Then in the second step the data is prepared in the desired format. Finally, the model that is represented in Figure 5.1 will be built. This is a general use case and all the models that are build can be represented in a similar graph.

5.2 Limitations

Every research has limitations to it, this one is no exception to that rule. One major limitation of this study is the generalizability. The goal of the questionnaire was to validate the results of the interview and thus to see whether or not domain experts agreed on the relevance of the pKPIs and predictors. Because of the low response for the questionnaire, especially for the HR domain, no claim can be made that these results are generalizable. However, since primary education is inspected by the Inspection of Education, most primary education foundations will have an overlapping interest in some KPIs. Since some KPIs have to be monitored for the inspection. Meaning that it can be verified whether or not some KPIs have to be monitored in order to pass the inspection and thus are needed for every primary school board, regardless of the value perceived by the domain experts. As for the reliability, the results can be considered reliable. Since most domain experts that were interviewed for this research had multiple years of experience in the field. It can be assumed that the domain experts supply reliable results as they represent the foundation (if applicable) which they are active for.

5.3 Recommendations

This research has an exploratory nature with the initial goal of retrieving insights from domain experts. However, an exploratory nature does not imply that the results of this research cannot be converted into actions. Therefore, a recommended use case for the results of this thesis is to use its findings as a starting point. When an interested party, such as a school foundation, wants to gather all relevant information needed for steering and decision making in one place (such as a dashboard), this research could serve as information source as to what this dashboard could contain. The findings of this research do not only contain KPIs and corresponding metrics, but they also provide information as to why these KPIs are relevant and what purpose these serve.

As stated in Section 5.1.3, data for some KPIs that were identified in this research may be missing. If an interested party would read this research and identifies one KPI previously not monitored by them but wants to monitor this in the future, the data may not be gathered. It is then recommended to gather this data, this could be done as easily as to transform existing data into the right format if this possibility is available. But gathering data could also be challenging, for instance if the data is rather abstract and requires a survey aimed at the staff. It is then recommended to consider the benefits of gathering this data for both short and long term. If these benefits outweigh the costs of gathering the data then it is definitely recommended to gather this data.

The final recommendation is to apply predictive modeling to the KPIs for which it was identified that this is desired. A predictive model may be inaccurate but may improve over time (if more data becomes available). It is always important to report on the accuracy of the model (or other suitable metrics) in order to make well informed decisions. It was made clear out of the interviews that many interviewees made their individual predictions on how certain KPIs would develop in the future. These predictions were often based on available data and sometimes on 'feeling'. Predictive models could back up these feelings to make argumentation more tangible. Another option is that the predictive models could open up discussion or further analysis if they supply a very different expectation for the future. In this case it may be desired to analyze why the model has a different prediction and whether it is justified by the supplied data. It could be that there are external factors that the model does not account for, so the human decision maker could still have the better estimation. But the goal of the predictive model is not to be right or wrong, it is to see if estimations can be justified or require further analysis.

5.4 Future research

This research had an exploratory nature, gaining insights that could be used in practice and for future research. As stated in Section 1.6, this research aimed to assist research in the following manners:

- Inspire research to verify the possible predictors of some pKPI identified in this thesis. This would mean that a follow-up research would utilize data of possible predictor(s) and use well known statistical tests to test whether the found predictor is statistically significant. Another approach would not only be to test significance but rather train a model that is able to capture more complex relations than simply linear relations.
- Use predictors and pKPIs and build EDM models in order to perform tasks such as predictive modeling.
- Collect data that was previously uncollected on possible predictors or pKPIs that were identified in this thesis and use them for the one of the above tasks.
- Future research could also aim to find more predictors for identified pKPIs.

All of the above ideas could be used in future research that aims to research predictive models in the context of primary education. The most suitable follow-up research would be a research where the most suitable model for a certain pKPI is picked. Thus picking one identified pKPI and testing which model would be best suited for this pKPI and its predictors and base this recommendation on suitable metrics.

Chapter 6

Conclusion

Business Intelligence (BI) has seen a major increase in relevance in the last decade. BI tools aim to supply its users with relevant information about KPIs. The application of BI finds itself in a wide variety of organizations, including primary education. BI can be extended with predictive modeling if this is desired by the users. Predictive modeling is an application of data mining, and applied to educational data is transformed into Educational Data Mining (EDM). This research is closely related to the field of EDM, in the sense that the possibilities of applying data mining models in the educational domain are discussed. However, EDM has a more technical focus whereas this research has a more exploratory nature to it. Since EDM often focuses on developing data mining models on an individual student level, such as identifying at risk students. In this research the focus lies on a more organization (foundation) wide level, where the aim was to identify pKPIs: a KPI that can serve as the dependent variable in data mining models. Along with these pKPIs it was investigated which predictors could be suitable for the corresponding pKPIs.

In order to reach the objectives the research question was stated as:

How can we provide primary education with pKPIs?

In order to supply an answer we divided the question into three sub research questions:

1. What pKPIs are relevant according to domain experts of elementary school departments?
2. What are potential predictors of the identified pKPIs?
3. Can we build a predictive model based on the identified predictors and pKPIs?

The first two questions were answered by interviewing domain experts. After the interviews a questionnaire was constructed which had as its goal to validate the results of the interviews. In total eight KPIs were identified for the educational domain and eleven for the HR domain. The results of the questionnaire can be used to prioritize different aspects of the pKPIs such as the desired metrics. These results can also be used to discard findings that are considered irrelevant by the respondents.

For the third sub research question, the results of the first and second sub research question were put into the context of predictive modeling. Where the sources of the desired data were analyzed and examples of predictive models were given. This was done in order to provide insights of what data miners or data scientists should consider when developing predictive models.

In conclusion, the main research question was answered by exploring what information, in the form of pKPIs, is relevant for domain experts. It was then analyzed how this information can be put into practice considering more aspects than only the variables. This research has an exploratory nature and can serve as a starting point for future data mining research or practice. The insights from the domain experts can be of great relevance for anyone who wants to apply data mining in a similar setting.

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Appendix A

Questionnaire questions

Wat is jouw domein van expertise?

- Educatie
- HR

KPI: Leerlingaantallen

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

- Het totaal aantal leerlingen op de peildatum (en dat van afgelopen jaren)
- Het totaal aantal leerlingen op het moment van monitoren, dus niet per se op de peildatum (en dat van afgelopen jaren)
- Het totaal aantal zij instromers/uitstromers per periode, bijvoorbeeld per kwartaal of per maand (en dat van afgelopen jaren)
- Het marktaandeel van de school (in termen van leerlingaantallen) relatief tot nabije scholen in de buurt. (en dat van afgelopen jaren)
- Ik heb geen interesse in deze KPI
- Anders:

Met welke reden monitor je het totaal aantal leerlingen (meerdere antwoorden mogelijk):

- Ik monitor deze KPI (nog) niet
- Ik heb het nodig voor het budgetteren

Anders:

Hoe relevant vind je het totaal aantal leerlingen:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van het totaal aantal leerlingen:

- Eens
- Oneens

Ik heb zelf al een voorspelling (prognose) van het totaal aantal leerlingen:

- Ja
- Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

- Ik gebruik een derde partij voor deze voorspelling (Gemeente bijvoorbeeld)
- Leerlingaantallen van de afgelopen jaren
- Uitstroom groep 8 van de afgelopen jaren
- Reguliere instroom (dus niet tussentijds) van de afgelopen jaren
- Tussentijdse instroom en/of uitstroom van de afgelopen jaren
- Marktaandeel van de school relatief tot nabije scholen
- Demografische ontwikkelingen (zoals nieuwbouwwijken)
- Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker
- 2.
- 3.
- 4.
5. zeer zeker

Met welke reden monitor je het totaal aantal zij instromers/uitstromers (meerdere antwoorden mogelijk):

- Ik monitor deze KPI (nog) niet
- Om te monitoren of het anders is dan verwacht (zoals meer in/uitstroom dan normaal)
- Om een verwachting te stellen voor het aantal leerlingen op de peildatum
- Omdat ik denk dat dit verband houdt met de algemene onderwijskwaliteit van de school (of die van scholen in de buurt)
- Anders:

Hoe relevant vind je het totaal aantal zij instromers/uitstromers:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van het totaal aantal zij instromers/uitstromers:

- Eens
- Oneens

Ik heb zelf al een voorspelling (prognose) van het totaal aantal zij instromers/uitstromers:

- Ja
- Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

- Tussentijdse instroom en/of uitstroom van de afgelopen jaren
- Demografische ontwikkelingen (zoals nieuwbouwwijken)
- Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker
- 2.
- 3.
- 4.
5. zeer zeker

Met welke reden monitor je het marktaandeel (meerdere antwoorden mogelijk):

- Ik monitor deze KPI (nog) niet
- Om een verwachting te stellen voor het aantal leerlingen op de peildatum
- Ik denk dat dit verband houdt met de algemene onderwijskwaliteit van de school (of die van scholen in de buurt)
- Anders:

Hoe relevant vind je het marktaandeel:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van het marktaandeel:

- Eens

Oneens

Ik heb zelf al een voorspelling (prognose) van het marktaandeel:

Ja

Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

Demografische ontwikkelingen (zoals nieuwbouwwijken)

Marktaandeel van de afgelopen jaren

Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker

2.

3.

4.

5. zeer zeker

KPI: Geografische verdeling

Ik vind de volgende meeteenheid voor deze KPI relevant:

Het aantal leerlingen per wijk die naar een bepaalde school gaan

Anders:

Ik heb geen interesse in deze KPI

Met welke reden monitor je de geografische verdeling (meerdere antwoorden mogelijk):

Ik monitor deze KPI (nog) niet

Ik ben geïnteresseerd waar mijn leerlingen wonen

Ik wil weten of de keus voor basisschool te maken heeft met de wijk waarin leerlingen en hun ouders wonen

Anders:

Hoe relevant vind je de geografische verdeling:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van de geografische verdeling:

- Eens
 Oneens

Ik heb zelf al een voorspelling (prognose) van de geografische verdeling:

- Ja
 Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

- Gegevens van geografische verdeling van voorgaande jaren
 Externe factoren zoals nieuwe wijken
 Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker
- 2.
- 3.
- 4.
5. zeer zeker

KPI: Welzijn en tevredenheid van leerlingen

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

- Algemene tevredenheid van leerlingen
- Algemene tevredenheid van ouders
- Algemene welzijn van leerlingen
- Tevredenheid van leerlingen over niet-toetsbare vaardigheden (zoals persoonlijke ontwikkeling)
- Tevredenheid van ouders over niet-toetsbare vaardigheden (zoals persoonlijke ontwikkeling)
- Anders:
- Ik heb geen interesse in deze KPI

Met welke reden monitor je het welzijn en tevredenheid van leerlingen (meerdere antwoorden mogelijk):

- Ik monitor deze KPI (nog) niet
- Ik wil mijn leerlingen monitoren op dit gebied
- Ik wil weten wanneer er afwijkingen zijn
- Omdat ik denk dat het verband houdt met de resultaten van de leerlingen
- Anders:

Hoe relevant vind je welzijn en tevredenheid van leerlingen:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van welzijn en tevredenheid van leerlingen:

- Eens
- Oneens

Ik heb zelf al een voorspelling (prognose) van welzijn en tevredenheid van leerlingen:

- Ja
- Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

- Resultaten van de leerlingen
- Welzijn en tevredenheid van de afgelopen jaren
- Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker
- 2.
- 3.
- 4.
5. zeer zeker

KPI: Absentie

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

- Gemiddelde absentie frequentie binnen een school
- Minimale/maximale absentie frequentie binnen een school
- Anders:
- Ik heb geen interesse in deze KPI

Met welke reden monitor je absentie (meerdere antwoorden mogelijk):

- Ik monitor deze KPI (nog) niet
- Rapportage in verband met leerplicht
- Ik denk dat het verband houdt met het welzijn en tevredenheid van leerlingen

Anders:

Hoe relevant vind je absentie:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van absentie:

- Eens
 Oneens

Ik heb zelf al een voorspelling (prognose) van absentie:

- Ja
 Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

- Welzijn en tevredenheid van leerlingen
 Absentie van de afgelopen jaren
 Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker
- 2.
- 3.
- 4.
5. zeer zeker

KPI: Referenties naar speciaal onderwijs

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

- Het totale aantal leerlingen dat in een bepaald jaar naar het speciaal onderwijs is verwezen (en dat van afgelopen jaren)
- Anders:
- Ik heb geen interesse in deze KPI

Met welke reden monitor je referenties naar speciaal onderwijs (meerdere antwoorden mogelijk):

- Ik monitor deze KPI (nog) niet
- Omdat dit te maken heeft met passend onderwijs
- Anders:

Hoe relevant vind je het aantal referenties naar speciaal onderwijs:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van het aantal referenties naar speciaal onderwijs:

- Eens
- Oneens

Ik heb zelf al een voorspelling (prognose) van het aantal referenties naar speciaal onderwijs:

- Ja
- Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

- De cijfers van de referenties naar speciaal onderwijs van de voorgaande jaren
- Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker
- 2.
- 3.
- 4.
5. zeer zeker

KPI: Herziene adviezen

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

- Het totale aantal (groep 8) adviezen dat moet worden herzien in een jaar (en de afgelopen jaren)
- Het totale aantal (groep 8) adviezen dat is bijgewerkt in een jaar (en de afgelopen jaren)
- Anders:
- Ik heb geen interesse in deze KPI

Met welke reden monitor je het aantal herziene adviezen (meerdere antwoorden mogelijk):

- Ik monitor deze KPI (nog) niet
- Deze KPI zegt mij iets over de kwaliteit van de adviezen
- Omdat ik denk dat deze KPI verband houdt met de prestatie binnen het voortgezet onderwijs
- Anders:

Hoe relevant vind je het aantal herziene adviezen:

1. Helemaal niet relevant
- 2.
- 3.
- 4.

5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van het aantal herziene adviezen:

- Eens
- Oneens

Ik heb zelf al een voorspelling (prognose) van het aantal herziene adviezen:

- Ja
- Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

- De cijfers voor herziene adviezen van voorgaande jaren
- Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker
- 2.
- 3.
- 4.
5. zeer zeker

KPI: Status van het voortgezet onderwijs

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

- Het percentage leerlingen dat op het geadviseerde niveau zit (3 jaar na het verlaten van groep 8), het percentage leerlingen dat onder het geadviseerde niveau zit en het percentage dat boven het geadviseerde niveau zit. Daarbij ook deze cijfers van de afgelopen jaren.
- De bovenstaande cijfers van andere scholen met (ongeveer) hetzelfde schoolgewicht. Daarbij ook deze cijfers van de afgelopen jaren.
- Anders:

Ik heb geen interesse in deze KPI

Met welke reden monitor je status van het voortgezet onderwijs (meerdere antwoorden mogelijk):

Ik monitor deze KPI (nog) niet

Deze KPI zegt iets over de kwaliteit van de adviezen

Ik wil monitoren of kansrijk wordt geadviseerd

Ik probeer doelen te zetten voor deze cijfers met inachtneming van de school weging

Om te monitoren of de leerlingen presteren zoals verwacht

Anders:

Hoe relevant vind je status van het voortgezet onderwijs:

1. Helemaal niet relevant

2.

3.

4.

5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van status van het voortgezet onderwijs:

Eens

Oneens

Ik heb zelf al een voorspelling (prognose) van status van het voortgezet onderwijs:

Ja

Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

School gewicht

De cijfers van status van het voortgezet onderwijs van voorgaande jaren

Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker
- 2.
- 3.
- 4.
5. zeer zeker

KPI: Studieresultaten

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

- Het percentage groep 8 leerlingen op 1f niveau en op 1s/2f niveau (referentieniveaus) binnen een school (per vak). Daarbij ook deze cijfers van de afgelopen jaren.
- De niveauwaardes voor elk vak in groep 8 binnen een school. Daarbij ook deze cijfers van de afgelopen jaren.
- Tussentijdse resultaten (voor groep 8) van de referentieniveaus en niveau waardes op een school. Daarbij ook deze cijfers van de afgelopen jaren.
- Tussentijdse toetsresultaten (inclusief groep 8) van de leerlingen op een school
- Anders:
- Ik heb geen interesse in deze KPI

Met welke reden monitor je de studieresultaten (meerdere antwoorden mogelijk):

- Ik monitor deze KPI (nog) niet
- Om te monitoren dat de signaleringswaarden niet worden behaald (bijvoorbeeld: 85% van de leerlingen moet op 1f niveau zitten)
- Om eigen gestelde doelen met betrekking tot referentieniveaus/niveauwaardes te monitoren
- Om de ontwikkeling van leerlingen in de gaten te houden
- Anders:

Hoe relevant vind je studieresultaten:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van studieresultaten in groep 8:

- Eens
- Oneens

Ik heb zelf al een voorspelling (prognose) van studieresultaten in groep 8:

- Ja
- Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

- Studieresultaten van eerdere jaren (bijvoorbeeld de referentieniveaus in groep 6/7)
- School weging
- Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker
- 2.
- 3.
- 4.
5. zeer zeker

KPI: Verzuim

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

- Gemiddelde verzuimduur afgelopen periode per school
- Meldingsfrequentie afgelopen periode per school
- Verzuimpercentage (actueel/gemiddeld/voortschrijdend) afgelopen periode per school
- Anders:
- Ik heb geen interesse in deze KPI

Met welke reden monitor je verzuim (meerdere antwoorden mogelijk):

- Ik monitor deze KPI (nog) niet
- Ik wil zien hoe het de afgelopen jaren heeft ontwikkeld
- Ik wil een prognose maken over het verwachte aantal benodigde invaldocenten
- Het verzuim moet onder een afgesproken percentage blijven
- Ik wil zoeken naar de reden voor het verzuim (bijvoorbeeld een verzuimcultuur of langdurige zieken)
- Omdat ik denk dat het verband houdt met werknemerstevredenheid
- Omdat ik denk dat het verband houdt met de onderwijskwaliteit
- Anders:

Hoe relevant vind je verzuim:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van verzuim:

- Eens
- Oneens

Ik heb zelf al een voorspelling (prognose) van verzuim:

- Ja
- Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

- De cijfers van verzuim duur/frequentie/percentage de afgelopen jaren
- Gevoel (zoals het vermoeden van aanwezigheid van een verzuimcultuur)
- Seizoen
- Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker
- 2.
- 3.
- 4.
5. zeer zeker

KPI: Loonkosten

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

- Totale loonkosten per periode
- Statistische waardes van de loonkosten (zoals gemiddelde, minimum en maximum)
- Anders:
- Ik heb geen interesse in deze KPI

Met welke reden monitor je loonkosten (meerdere antwoorden mogelijk):

- Ik monitor deze KPI (nog) niet
- Ik wil weten hoe de begrootte loonkosten zijn ten opzichte van de werkelijke loonkosten
- Anders:

Hoe relevant vind je loonkosten:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van loonkosten:

- Eens
- Oneens

Ik heb zelf al een voorspelling (prognose) van loonkosten:

- Ja
- Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

- De loonkosten van afgelopen perioden
- Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker
- 2.
- 3.
- 4.
5. zeer zeker

KPI: Beschikbaar FTE

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

- Totaal aantal FTE beschikbaar per maand (of andere periode) op een school
- Totaal aantal werknemers beschikbaar per maand op een school
- Het aantal leraren ten opzichte van leerlingen op een school
- Gemiddelde groepsgrootte van een school
- Gemiddeld aantal FTE beschikbaar per team
- Gemiddelde dienstbetrekking omvang
- Anders:
- Ik heb geen interesse in deze KPI

Met welke reden monitor je beschikbaar FTE (meerdere antwoorden mogelijk):

- Ik monitor deze KPI (nog) niet
- Ik wil weten hoeveel werknemers verantwoordelijk zijn voor een leerling en of er genoeg geïnvesteerd kan worden in een kind
- Ik wil weten of ik mijn leraren kan motiveren om meer te werken als de gemiddelde dienstbetrekking omvang laag is
- Anders:

Hoe relevant vind je beschikbaar FTE:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van beschikbaar FTE:

- Eens
- Oneens

Ik heb zelf al een voorspelling (prognose) van beschikbaar FTE:

- Ja
- Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

- Beschikbaar FTE van de afgelopen jaren
- Studentenaantallen
- Externe factoren (zoals lerarentekort)
- Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker
- 2.
- 3.
- 4.
5. zeer zeker

KPI: Studenten op de lerarenopleiding

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

- Het totaal aantal huidige studenten op de lerarenopleiding
- De instroom en uitstroom afgelopen jaar van de lerarenopleiding
- Anders:
- Ik heb geen interesse in deze KPI

Met welke reden monitor je het aantal studenten op de lerarenopleiding (meerdere antwoorden mogelijk):

- Ik monitor deze KPI (nog) niet
- Ik wil weten of er de komende jaren voldoende personeel beschikbaar komt
- Anders:

Hoe relevant vind je het aantal studenten op de lerarenopleiding:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van het aantal studenten op de lerarenopleiding:

- Eens
- Oneens

Ik heb zelf al een voorspelling (prognose) van het aantal studenten op de lerarenopleiding:

- Ja
- Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

- De cijfers van studenten op de lerarenopleiding van de afgelopen jaren
- Anders, namelijk:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker
- 2.
- 3.
- 4.
5. zeer zeker

KPI: Personeel welzijn en tevredenheid

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

- Het aantal werknemers tevredenheidsonderzoeken afgelopen jaar per school
- Het gemiddelde aantal ontwikkelgesprekken van de werknemers per school
- Resultaten van een (kwaliteit)vragenlijst
- eNPS, (employee) Net Promotor Score
- Anders:
- Ik heb geen interesse in deze KPI

Met welke reden monitor je personeel welzijn en tevredenheid (meerdere antwoorden mogelijk):

- Ik monitor deze KPI (nog) niet
- Het geeft inzicht in het leiderschap niveau van de school
- Om te kijken of leraren tevreden zijn over de school als werkgever (en dus kunnen optreden als ambassadeur)
- Omdat ik denk dat het verband houdt met de resultaten van de leerlingen
- Omdat ik denk dat het verband houdt met het welzijn en geluk van de leerlingen
- Anders:

Hoe relevant vind je personeel welzijn en tevredenheid:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben personeel welzijn en tevredenheid:

- Eens
- Oneens

Ik heb zelf al een voorspelling (prognose) van personeel welzijn en tevredenheid:

- Ja

Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

De cijfers van personeel welzijn en tevredenheid van de afgelopen jaren

Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker

2.

3.

4.

5. zeer zeker

KPI: Personeelsverloop

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

Totaal aantal nieuwe werknemers binnen een bepaalde periode

Totaal aantal werknemers dat is weggegaan binnen een bepaalde periode

De redenen voor de werknemers die zijn weggegaan

Het verlooppercentage van een bepaalde periode

Percentage werknemers dat binnen 2 jaar weg gaat

Anders:

Ik heb geen interesse in deze KPI

Met welke reden monitor je personeelsverloop (meerdere antwoorden mogelijk):

Ik monitor deze KPI (nog) niet

Ik wil weten hoe de organisatie het doet als werkgever

Ik wil weten wat de belangrijkste redenen zijn voor vertrek (zoals pensioen)

- Omdat ik denk dat het verband houdt met werknemer tevredenheid en welzijn
- Omdat ik denk dat het verband houdt met de onderlinge verbondenheid van de werknemers
- Omdat ik denk dat het verband houdt met leerlingresultaten
- Anders:

Hoe relevant vind je personeelsverloop:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van personeelsverloop:

- Eens
- Oneens

Ik heb zelf al een voorspelling (prognose) van personeelsverloop:

- Ja
- Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

- Personeelsverloop van de afgelopen jaren
- Investerings in opleidingen voor het personeel
- Leeftijd (in verband met pensioen)
- Benchmarkcijfers (bijvoorbeeld: gemiddeld x% van het personeel verlaat de organisatie binnen een maand voor een andere werkgever)
- Externe factoren zoals het lerarentekort (veel concurrerende werkgevers)
- Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker
- 2.
- 3.
- 4.
5. zeer zeker

KPI: Functie doorstroom

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

- Het aantal geregistreerde functiewisselingen op een school
- Het percentage (en totale aantal) van personeel dat van OOP (onderwijs ondersteunend personeel) naar OP (onderwijsgevend personeel) gaat op een school
- Anders:
- Ik heb geen interesse in deze KPI

Met welke reden monitor je functie doorstroom (meerdere antwoorden mogelijk):

- Ik monitor deze KPI (nog) niet
- Ik wil weten op welke scholen er (genoeg) doorgroeimogelijkheden zijn
- Ik wil carrière paden creëren op scholen om meer personeel te krijgen
- Omdat ik denk dat het verband houdt met verbondenheid van het personeel
- Anders:

Hoe relevant vind je functie doorstroom:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van functie doorstroom:

- Eens
- Oneens

Ik heb zelf al een voorspelling (prognose) van functie doorstroom:

- Ja
- Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

- Personeel tevredenheid en welzijn
- De cijfers van functie doorstroom van de afgelopen jaren
- Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker
- 2.
- 3.
- 4.
5. zeer zeker

KPI: Werkdruk

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

- Hoeveelheid verwachte taken in FTE ten opzichte van het beschikbare FTE
- Anders:
- Ik heb geen interesse in deze KPI

Met welke reden monitor je werkdruk (meerdere antwoorden mogelijk):

- Ik monitor deze KPI (nog) niet

Om te monitoren of er genoeg personeel in huis is om alle taken te volbrengen

Anders:

Hoe relevant vind je werkdruk:

1. Helemaal niet relevant

2.

3.

4.

5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van werkdruk:

Eens

Oneens

Ik heb zelf al een voorspelling (prognose) van werkdruk:

Ja

Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

Werkdruk van de afgelopen jaren

Leerlingaantallen

Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker

2.

3.

4.

5. zeer zeker

KPI: Ontwikkeling / verdere training personeel

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

- Hoeveel tijd wordt er gespendeerd per werknemer aan verdere training/ontwikkeling (cijfers zoals gemiddelde, minimum en maximum)
- Percentage van salariskosten uitgegeven aan verdere training/ontwikkeling
- Anders:
- Ik heb geen interesse in deze KPI

Met welke reden monitor je ontwikkeling van personeel (meerdere antwoorden mogelijk):

- Ik monitor deze KPI (nog) niet
- Om te meten of er genoeg tijd wordt besteed aan verdere ontwikkeling
- Omdat we streven naar duurzame inzetbaarheid
- Omdat ik denk dat het verband houdt met personeelsverloop
- Anders:

Hoe relevant vind je ontwikkeling van personeel:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van ontwikkeling van personeel:

- Eens
- Oneens

Ik heb zelf al een voorspelling (prognose) van ontwikkeling van personeel:

Ja

Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

Cijfers van personeel ontwikkeling afgelopen jaren

Cijfers van personeelsverloop

Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker

2.

3.

4.

5. zeer zeker

KPI: Zij-instroom (Werknemers die beginnen en starten aan PABO)

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

Totale aantal van zij-instromers dat blijft na afronden van opleiding

Percentage van zij-instromers dat blijft na afronden van opleiding

Anders:

Ik heb geen interesse in deze KPI

Met welke reden monitor je zij-instroom (meerdere antwoorden mogelijk):

Ik monitor deze KPI (nog) niet

Omdat ik wil weten of het de investering waard is

Anders:

Hoe relevant vind je zij-instroom:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van zij-instroom:

- Eens
- Oneens

Ik heb zelf al een voorspelling (prognose) van zij-instroom:

- Ja
- Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

- Cijfers van zij-instroom van de afgelopen jaren
- Personeel tevredenheid en welzijn
- Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker
- 2.
- 3.
- 4.
5. zeer zeker

KPI: Verdeling personeel

Ik vind de volgende meeteenheid voor deze KPI relevant (meerdere antwoorden mogelijk):

- De verdeling van het personeel gebaseerd op geslacht per school
- De verdeling van het personeel gebaseerd op leeftijd per school
- De verdeling van het personeel gebaseerd op per functie/functiegroep
- Ik zou graag voor alle eerder genoemde KPI's een verdeling willen zien gebaseerd op geslacht/leeftijd/-functie per school
- De verdeling van het personeel gebaseerd op specialisme per school (indien aanwezig)
- Anders:
- Ik heb geen interesse in deze KPI

Met welke reden monitor je verdeling personeel (meerdere antwoorden mogelijk):

- Ik monitor deze KPI (nog) niet
- Ik vind diversiteit onder de werknemers belangrijk
- Ik wil voldoende specialisme op een school
- Anders:

Hoe relevant vind je verdeling personeel:

1. Helemaal niet relevant
- 2.
- 3.
- 4.
5. Extreem relevant

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van verdeling personeel:

- Eens
- Oneens

Ik heb zelf al een voorspelling (prognose) van verdeling personeel:

- Ja

Nee

Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):

Externe factoren zoals de economische staat van het land

Cijfers van verdeling personeel van de afgelopen jaren

Anders:

Hoe zeker ben je van de voorspelling die je maakt:

1. Helemaal niet zeker

2.

3.

4.

5. zeer zeker

Appendix B

Interview results

KPI	Student numbers
Domain	Education
Number of interviewees	3
Explanation	This KPI measures how many students there are in a specific school. Also the development (with interim inflow and outflow) of the student numbers over the course of time.
Metrics	<ul style="list-style-type: none">• Total number of current students (either on the reference date or current date).• Total numbers for (interim) inflow and outflow (Interim inflow/outflow measures how many students start or leave the school in the course of the year, so not at the start of the school year).• Ratio of students in the lower classes/upper classes.• Market share: what is the market share with respect to direct competition (so nearby schools). This market share is measured in student numbers. Direct competition is fairly abstract, since it includes nearby schools but not necessarily schools in the same city (in a big city the schools north and south could not be considered direct competition).

Purpose	<p>For total student numbers:</p> <ul style="list-style-type: none"> • Interesting to see the trendline for the student numbers. • This is most important on the reference date, because they receive funds for the student numbers on the reference date. Thus it is needed for budgeting. <p>For inflow/outflow:</p> <ul style="list-style-type: none"> • If the inflow or outflow is more than usual then something might be happening, a nearby school could be functioning lower than normal or vice versa (the own school could be functioning lower than normal thus higher outflow). • For inflow: Aside from the total inflow, the interviewee expressed a need for a certain weight of a new group of students. Because some students need more attention than others and thus the ‘weight’ of this group is higher than the actual number of students in terms of workload. • For outflow: This is relevant because of the student numbers you have. <p>For market share:</p> <ul style="list-style-type: none"> • Market share is an indicator of the education quality of the school with respect to other nearby schools.
Predictor of	<p>Interim inflow and outflow is a potential predictor of general education quality (or that of nearby schools).</p> <p>Market share is a potential predictor of education quality.</p>
Need for forecast	<p>For total student numbers: Yes (3)</p> <p>For inflow/outflow: Yes (1)</p> <p>For market share: Yes (1)</p>
Interviewee forecast	<p>For total student numbers: Yes (3)</p> <p>For inflow: Yes (1)</p>

	<p>For outflow: No, because you cannot estimate well how many students move to another city (this fluctuates too much to make a good prediction). (1)</p> <p>For market share: Yes (1)</p>
Potential predictors	<p>For total student numbers:</p> <ul style="list-style-type: none"> • The municipality provides a forecast about student numbers which can be used for estimating the inflow. • Third parties also make forecasts that can be used for inflow. • (expected) outflow out of group 8 (dependent of the reference date). • Interim inflow of previous years. • Market share. • Demographic developments. • Feeling. • External factors such as new neighborhoods. • Historical data such as: the average outflow of the previous years, the average inflow (also through the language school) of the previous years. <p>For inflow:</p> <ul style="list-style-type: none"> • Historical data such as the trend from previous years. <p>For market share:</p> <ul style="list-style-type: none"> • Feeling. • Estimation of school principal. • Historical data: the market share of previous years.
Confidence in prediction	<p>For total student numbers: High (2) Low (1)</p> <p>For inflow/outflow: High (1)</p> <p>For market share:</p>

	Middle high in best case scenario, low in worst case scenario. (1)
Priority	For total student numbers: High (1) Low (1) For inflow: High (1)

KPI	Geographical distribution
Domain	Education
Number of interviewees	1
Explanation	This KPI shows (preferably with a map) from which neighborhoods the students are from. So it answers the question ‘where do my students live?’.
Metrics	A (heat)map that shows where students live in the local area.
Purpose	The purpose is to research why parents from certain neighborhoods pick certain schools. In the case that the results are divergent from what is expected then it can be researched why. This is especially relevant when a school is losing students. A school wants to research if the choice of the school is dependent on the neighborhood in which the parents (and student) live.
Predictor of	-
Need for forecast	Yes
Interviewee forecast	Yes
Potential predictors	External factors such as new neighborhoods.
Confidence in prediction	Low
Priority	High for the school board. Low for a principal with a full school.

KPI	Student satisfaction / student wellbeing NOTE: This KPI was initially split into “satisfaction for non-testable development” and ‘Student wellbeing and involvement’
Domain	Education
Number of interviewees	2

Explanation	<ul style="list-style-type: none"> • How satisfied are the children, parents and teachers about the skills that can not be tested (such as personal development). • How are the children/students feeling, how are they experiencing the school environment.
Metrics	<ul style="list-style-type: none"> • Survey. • Also the satisfaction of the parents should be measured.
Purpose	<p>For satisfaction for non-testable development:</p> <ul style="list-style-type: none"> • Monitoring when outliers occur. <p>For student wellbeing:</p> <ul style="list-style-type: none"> • Monitoring of children.
Predictor of	Student wellbeing is a potential predictor of student results.
Need for forecast	No (2)
Interviewee forecast	No (1)
Potential predictors	-
Confidence in prediction	-
Priority	For student wellbeing: High (1)

KPI	Absence
Domain	Education
Number of interviewees	1
Explanation	This KPI denotes how often children are absent.
Metrics	Average frequency of absence within a school (within a certain period).
Purpose	You have to report for education obligation ('leerplicht') on a school level. Furthermore, if the wellbeing and involvement of a child is low then this is often due to absence.
Predictor of	Student wellbeing and involvement
Need for forecast	No
Interviewee forecast	No

Potential predictors	-
Confidence in prediction	-
Priority	Middle

KPI	References to special education
Domain	Education
Number of interviewees	1
Explanation	The number of students that are yearly referenced to special education in a school.
Metrics	This KPI is a number that represents the number of references to special education for a school.
Purpose	This has to be monitored because of the 'suitable education' initiative of the dutch government.
Predictor of	-
Need for forecast	Yes, but no high need.
Interviewee forecast	Yes
Potential predictors	Historical data of this KPI.
Confidence in prediction	High
Priority	Middle-high

KPI	Revised advices
Domain	Education
Number of interviewees	1
Explanation	How much advices given to children with regards to secondary education (VMBO, HAVO, VWO) has the school revised this year.
Metrics	Total number of advices that have been revised for a certain year.
Purpose	This KPI tells something about the quality of the secondary education advices together with the KPI 'status of secondary education'.
Predictor of	-
Need for forecast	No
Interviewee forecast	-
Potential predictors	-
Confidence in prediction	-
Priority	-

KPI	Status of secondary education
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Domain	Education
Number of interviewees	5
Explanation	How are students performing in secondary education three years after they leave the last group of primary education (group 8).
Metrics	<ul style="list-style-type: none"> • This KPI can be measured by the percentage of students that are on the high school level of the advice they received for secondary education, the percentage that is under the high school level of their advice and the percentage that is above the level of their advice. • What is the development over the last years: which advices were revised and what can be seen 3 years later for those students. Also: what are schools with the same school weight advising? How is that different from this school?
Purpose	<ul style="list-style-type: none"> • This KPI tells something about the quality of the secondary education advices together with the KPI 'revised advices'. • Goals should be set with the school weight in mind. • The interviewee started this KPI as outflow, however what was more important was the context, so where (to which high school) are the children going. She then explained that this KPI was about answering the questions 'did we fulfill our job as an elementary school?' and 'do I give the students enough knowledge for this next step? '. Because if it is not the case then you can adjust the education program. • Giving more promising advices, give the students a chance to receive higher advice. This KPI gives insight whether or not the school gives promising advices.
Predictor of	-
Need for forecast	No (2)
Interviewee forecast	-
Potential predictors	School weight
Confidence in prediction	-
Priority	High (2)

	Middle (1)
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KPI	Study results
Domain	Education
Number of interviewees	4
Explanation	<ul style="list-style-type: none"> • What are the scores for the reference levels in group 8. • What are the scores for (particularly) calculating ('rekenen') and reading comprehension ('begrijpend lezen'). Not only in the last year on the end test but also mid tests from group 6 on. Also look at level values ('niveau waardes') and the growth of students in context of the school weight. • The results of the students for language ('taal'), reading (comprehension), and calculating. • What are the intermediate test results and reference levels (before group 8). Also what are the end results in terms of reference levels. So this interviewee actually had two KPIs: intermediate and end results.
Metrics	<ul style="list-style-type: none"> • The percentage of the students are on 1f level and the percentage that is on 1s/2f level. • The scores of the students for each subject for each year. • Level values (example: percentage of students that is on each level). • Intermediate test results and reference levels.

Purpose	<ul style="list-style-type: none"> • A primary school should have 85 % of their students on 1f level. The percentage of 1s/2f level is determined by the school weight. • Early stage of forecasting, if something is standing out then have a dialogue. • This is the goal of the school, the mission. Is the expectation for the 1s/2f scores being met. • Internally you want to monitor the education level, do students receive the education that they should be getting and do they reach the level you expect them to.
Predictor of	-
Need for forecast	For reference levels scores group 8: Yes (4)
Interviewee forecast	For reference levels scores group 8: No (2) Yes (2) For intermediate results: No (1)
Potential predictors	For reference levels scores group 8: Reference levels in group 6/7, so historical data.
Confidence in prediction	For reference levels scores group 8: High (2)
Priority	For reference levels scores group 8: High (2) Middle (1) For intermediate results: A little less important but still important. (1)

KPI	Absenteeism
Domain	HR
Number of interviewees	6
Explanation	This KPI measures the absence of the employees (teaching staff).

Metrics	<ul style="list-style-type: none">• Duration (average duration per school, or total duration in FTE's).• Frequency (frequency per school).• Percentage (per school), with (moving) average of previous 12 months.• Additionally, you also want to measure this for each age category (See KPI: 'staff division').
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Purpose	<ul style="list-style-type: none"> • You want to see how absenteeism has developed in previous years and for each (age) category. • How much substitute teachers are necessary. • On foundation level they need to stay under 4%, if there is an expectation that this will not be met then measures have to be taken. This expectation is based on historical data. Note: this 4% is only for the organization the interviewee worked for and not lawful. • If there is a lot of absenteeism then it says something about the vitality of your employees. The work for the ‘healthy’ staff becomes less joyful because they have to do the work of sick coworkers. <p>It is especially important to monitor all three. For instance: if you have two employees who have a long sickness then you have ‘only’ two sick employees. However, if you have a high frequency with short duration then there may be an absenteeism culture. In both these cases the percentage can be about the same.</p> <ul style="list-style-type: none"> • Monitoring how often teachers are sick. • Benchmark these numbers against the national absenteeism percentage in primary education. • This KPI indicates how healthy your organization is (or part of the organization). A high absenteeism percentage says something and then you can start a research to discover the reason.
Predictor of	Education quality. When the absenteeism has been high for a couple of years then the education results may drop.
Need for forecast	Yes (5) No (1)
Interviewee forecast	Yes (4) No (1)

Potential predictors	<ul style="list-style-type: none"> • Historical data (This can be of frequency, duration and percentage). • External factors. • Feeling. • Time of year.
Confidence in prediction	High (3) Low (1)
Priority	High (5) Middle (1)

KPI	Labor costs
Domain	HR
Number of interviewees	1
Explanation	This KPI measures the cost for staff. It answers the question ‘What is the average cost of labor?’ This has to do with the spread of ages among workers.
Metrics	<ul style="list-style-type: none"> • Average cost of labor (minimum, maximum, modus, median). • The difference between budgeted salary costs and actual costs.
Purpose	-
Predictor of	-
Need for forecast	-
Interviewee forecast	-
Potential predictors	-
Confidence in prediction	-
Priority	-

KPI	Available FTE
Domain	HR
Number of interviewees	4

Explanation	This KPI revolves around the amount of staff (teachers) available and how this relates to the number of students.
Metrics	<ul style="list-style-type: none"> • Total amount of FTE (per school). • Total amount of staff (per school). • How many teachers are there per student. • Average group size per school. • Size of fte per team (fte with respect to a team). • Size of employment: what is the part time percentage, thus what percentage of the staff works part time. Also: what is your average size of employment: so average hours / hours of 1 fte, for instance: a size of employment of 80% means that on average an employee works 0.8 * 40 hours a week.
Purpose	<p>For total amount of FTE/staff:</p> <ul style="list-style-type: none"> • It is interesting to measure this along with the earnings to see if the employees are paid fairly. <p>For FTE with regards to student numbers/team:</p> <ul style="list-style-type: none"> • An organization wants to see how many employees are responsible for each student (or group of students). It says something about how the money is spreaded. The question then remains how much time you can invest in a student and whether that is enough. <p>For size of employment:</p> <ul style="list-style-type: none"> • Due to employee shortage you want to make sure that ‘sitting’ staff are working more, so utilizing more of the staff you have. Because currently there are almost no new teachers you can hire (due to shortage) thus a higher employment size on average is desired.
Predictor of	-
Need for forecast	For total amount of FTE/staff: Yes (1)

	For size of employment: Yes (1)
Interviewee forecast	For total amount of FTE/staff: Yes (1) For FTE with regards to students/team: Yes (1) For size of employment: No (1)
Potential predictors	For total amount of FTE/staff: <ul style="list-style-type: none">• Number of students. For FTE with regards to students/team: <ul style="list-style-type: none">• External factors such as teacher shortage: due to the teacher shortage more people will be hired that are less qualified.
Confidence in prediction	For total amount of FTE/staff: High (1) For FTE with regards to students/team: High (1)
Priority	For total amount of FTE/staff: High (1) For FTE with regards to students/team: High (1) For size of employment: High (1)

KPI	Students on teacher education.
Domain	HR
Number of interviewees	1
Explanation	How much inflow and outflow is there on the education for teachers.
Metrics	-
Purpose	Follow potential new teachers.

Predictor of	-
Need for forecast	-
Interviewee forecast	-
Potential predictors	-
Confidence in prediction	-
Priority	-

KPI	Employee satisfaction/wellbeing
Domain	HR
Number of interviewees	5
Explanation	<ul style="list-style-type: none"> • The interviewee initially called this KPI ‘employee satisfaction researches’. She wants to measure how many conversations (or researches) an employee has about his/her satisfaction. • The interviewee initially called this ‘employee happiness’. She also had a separate KPI ‘development conversations’ which is incorporated in this KPI. <p>Employee happiness of 5 components that you can measure:</p> <ul style="list-style-type: none"> – What does the organization do about professionalization – What do employees think about autonomy. – Vitality of employees (has to do with absenteeism). – How connected are the employees to each other and to the organization. – How meaningful do the employees think their job is. <p>These 5 components can be measured with a quality survey.</p> <ul style="list-style-type: none"> • You can use the ENPS: (employee) Net promoter score. Which basically says what percentage of your staff would recommend you as an employer and also how high you score the eNPS is important.

Metrics	<ul style="list-style-type: none"> • Average employee satisfaction researches per teacher (or staff member) per school. Also the (average) amount of development conversations an employee has each year. • Results quality survey (see explanation). • eNPS
Purpose	<p>For employee satisfaction researches/development conversations:</p> <ul style="list-style-type: none"> • This gives insight into the leadership within a school. How important does the school leader find the development of his/hers employees. <p>For employee happiness:</p> <ul style="list-style-type: none"> • With happy teachers you hope to get happy students. • Monitoring <p>For eNPS:</p> <ul style="list-style-type: none"> • To see if your employees are all ‘ambassadors’, if you have a high percentage then you have a lot of ambassadors, otherwise not.
Predictor of	<p>For employee happiness:</p> <p>Student results, if the wellbeing of the teacher decreases then the student results may also decrease.</p>
Need for forecast	<p>For employee satisfaction researches:</p> <p>Yes (1)</p> <p>For employee happiness:</p> <p>Yes (1)</p> <p>No (1)</p>
Interviewee forecast	<p>For employee satisfaction researches:</p> <p>Yes (1)</p> <p>No (1)</p> <p>For employee happiness:</p> <p>No (2)</p>
Potential predictors	<p>For employee satisfaction researches:</p>

	Historical data
Confidence in prediction	-
Priority	For employee satisfaction researches: High (1) For employee happiness: High (1) Middle high (1)

KPI	Staff division
Domain	HR
Number of interviewees	4
Explanation	<ul style="list-style-type: none"> • How is the staff divided based on: <ul style="list-style-type: none"> – Age – Man/woman ratio – Function(group) • It is also interesting for most KPIs what the KPI value is per function(category) or gender. NOTE: the interviewee actually said this one as an extra KPI but this is more general applicable. • Teachers can have had an education for a certain specialism. Thus you can measure how many teachers you have with what specialism.
Metrics	Division of staff based on: <ul style="list-style-type: none"> • Age • Man/woman ratio • Function(group) • Teaching specialism

Purpose	For employee satisfaction researches/development conversations: <ul style="list-style-type: none"> • Diversity, important for the dynamics of the team and for the children (also cultural diversity). The goal is that every student should be able to recognize him/herself in a teacher, so it is desired to have diverse teachers. • Schools have to guarantee that they have enough specialists to make sure that the supply is enough for the students.
Predictor of	-
Need for forecast	-
Interviewee forecast	Yes, for the woman/man ratio. (1)
Potential predictors	For man/woman ratio: Economical status of a country, when a country is doing bad then men are more attracted towards teachers than when a country is doing economically well.
Confidence in prediction	For man/woman ratio: High
Priority	High (1) Middle high (1)

KPI	Staff turnover, inflow/outflow
Domain	HR
Number of interviewees	3
Explanation	<ul style="list-style-type: none"> • This KPI measures how long employees stay, how many leave and how many are coming in. • One interviewee initially called it 'outflow' but this is the same.

Metrics	<ul style="list-style-type: none"> • Total amount of new employees that are hired. • Total amount of employees that have left. • Reasons for leave (for instance: x% leaves for retirement). • Staff turnover: turnover percentage is preferred which is calculated by: leaving employees / average amount of employees * 100. • Amount (or percentage) of staff that leaves within 1 or 2 years.
Purpose	<ul style="list-style-type: none"> • It is important to know why employees leave. This reason is important since you can then see how the organization is doing as an employer. • This KPI says something about the happiness of the staff. It has to do with how connected the employees are. • Staff turnover is healthy but not too much of it, because you don't want too much staff leaving the organization. • The turnover also says something about the employee satisfaction, thus how the organization acts as an employer. • Monitoring how much staff the organization is losing and why. Potential reasons for leave: retirement, resignation, employee satisfaction.
Predictor of	<p>Education quality.</p> <p>Employee satisfaction.</p>
Need for forecast	Yes (3)
Interviewee forecast	<p>Yes (2)</p> <p>No (1)</p>

Potential predictors	<ul style="list-style-type: none"> • Historical data • External factors such as corona • Feeling • Teacher shortage, if there are a lot of vacancies closer to the employees home it might be attractive to leave. • Although one interviewee did not have a forecast she thinks you can forecast it with: <ul style="list-style-type: none"> – Feeling, people knowledge. – Investment in attention for your employees. – Spending on employee further training. • Legal retirement age. • Benchmarknumbers (For example: x% of staff leave because of moving), these numbers are dependent on the organization.
Confidence in prediction	High (2)
Priority	High (3)

KPI	Function throughput
Domain	HR
Number of interviewees	2
Explanation	<ul style="list-style-type: none"> • This KPI measures how many function changes there are within a school. • Function throughput from OOP ('onderwijs ondersteunend personeel') to OP ('onderwijsgevend personeel').
Metrics	The percentage of staff that goes from OOP to OP.

Purpose	<ul style="list-style-type: none"> • Research on which schools have a lot of growth possibilities. • This is because of the teacher shortage, you want more teachers for classes. The organization wants to create career paths for education assistants that want to become teachers.
Predictor of	How connected the employees are. Quality of leadership.
Need for forecast	For OOP to OP: Yes (1)
Interviewee forecast	For OOP to OP: No (1)
Potential predictors	For OOP to OP: Quality of leadership
Confidence in prediction	-
Priority	For OOP to OP: Middle (1)

KPI	Workload
Domain	HR
Number of interviewees	1
Explanation	How many FTE do you have and is this in line with how many responsibilities/tasks a person has.
Metrics	-
Purpose	The purpose is to see whether all tasks can be performed with the hours you have at your disposal. Can the discussed high workload of teachers be made tangible with numbers is the question here.
Predictor of	-
Need for forecast	Yes
Interviewee forecast	Yes
Potential predictors	number of students, the amount of tasks remains about the same. But with less students then you have less FTE at your disposal so with fewer students the workload increases.
Confidence in prediction	Low
Priority	High

KPI	Further training
Domain	HR
Number of interviewees	2
Explanation	<ul style="list-style-type: none"> • How much time do teachers spend on further training. On a foundation level you can measure this with averages, minimum, maximum and percentiles. Average alone does not say enough so you need multiple metrics. • How much is being spent on further training of employees. You want to see the percentage of money spent relative to the salaries (money spent on further training / salary sum * 100).
Metrics	<ul style="list-style-type: none"> • Time spent on further training (on average, minimum, maximum). • Percentage of total salary costs spent on training.
Purpose	<ul style="list-style-type: none"> • To see how much time is spent on further training and if this fits within their task policy. • The organization wants to see staff develop and improve. Because then you have sustainable employability ('duurzame inzetbaarheid'). Also if you develop the staff then they might be more connected to the organization.
Predictor of	-
Need for forecast	Yes (1)
Interviewee forecast	Yes (1)
Potential predictors	For salary cost spent: Actions that are taken (such as a new policy or investments).
Confidence in prediction	For salary cost spent: High (1)
Priority	For salary cost spent: High (1)

KPI	Side inflow
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Domain	HR
Number of interviewees	1
Explanation	Side inflow means how many people are hired and start the PABO education (teacher education). Moreover, how many of these people stay to work at the organization after finishing their education.
Metrics	You want both the percentage and absolute value of the side inflow that stays. Because if you have 3 out of 4 that stay it is 75% but it can easily drop to 50% thus both values are desired.
Purpose	A lot of time and money is invested in side inflow and losing them is not desired.
Predictor of	-
Need for forecast	Yes
Interviewee forecast	-
Potential predictors	-
Confidence in prediction	-
Priority	Middle

Appendix C

Questionnaire results

Question	Answers
Wat is jouw domein van expertise?	<ul style="list-style-type: none">• Educatie (4)• HR (1)
Ik vind de volgende meeteenheid voor leerlingaantallen relevant (meerdere antwoorden mogelijk):	<ul style="list-style-type: none">• Het totaal aantal leerlingen op het moment van monitoren, dus niet per se op de peildatum (en dat van afgelopen jaren) (2)• Het totaal aantal leerlingen op de peildatum (en dat van afgelopen jaren) (2)• Het totaal aantal zij instromers/uitstromers per periode, bijvoorbeeld per kwartaal of per maand (en dat van afgelopen jaren) (1)
Met welke reden monitor je het totaal aantal leerlingen (meerdere antwoorden mogelijk):	<ul style="list-style-type: none">• Ik heb het nodig voor het budgetteren (2)• Organisatie, ow niveau (1)• Zij instroom, uitstroom, terugstroom wordt mn gemonitord ivm passend onderwijs” (1)

Hoe relevant vind je het totaal aantal leerlingen:	<ul style="list-style-type: none"> • 5 (2) • 4 (2)
Ik heb er behoefte aan om een voorspelling (prognose) te hebben van het totaal aantal leerlingen:	<ul style="list-style-type: none"> • Eens (3) • Oneens (1)
Ik heb zelf al een voorspelling (prognose) van het totaal aantal leerlingen:	<ul style="list-style-type: none"> • Ja (4)
Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Ik gebruik een derde partij voor deze voorspelling (Gemeente bijvoorbeeld) (3) • Demografische ontwikkelingen (zoals nieuwbouwwijken) (3) • Aanmeldingen (1) • Marktaandeel van de school relatief tot nabije scholen (1) • begroting en formatie (1) • Leerlingaantallen van de afgelopen jaren (2) • Uitstroom groep 8 van de afgelopen jaren (1) • Reguliere instroom (dus niet tussentijds) van de afgelopen jaren (1) • Tussentijdse instroom en/of uitstroom van de afgelopen jaren (1)

Hoe zeker ben je van de voorspelling die je maakt:	<ul style="list-style-type: none"> • 4 (2) • 5 (1) • 2 (1)
Met welke reden monitor je het totaal aantal zij instromers/uitstromers (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Omdat ik denk dat dit verband houdt met de algemene onderwijskwaliteit van de school (of die van scholen in de buurt) (2) • Organisatie (1) • Om een verwachting te stellen voor het aantal leerlingen op de peildatum (2) • Om te monitoren of het anders is dan verwacht (zoals meer in/uitstroom dan normaal) (2)
Hoe relevant vind je het totaal aantal zij instromers/uitstromers:	<ul style="list-style-type: none"> • 4 (3) • 2 (1)
Ik heb er behoefte aan om een voorspelling (prognose) te hebben van het totaal aantal zij instromers/uitstromers:	<ul style="list-style-type: none"> • Eens (2) • Oneens (2)
Ik heb zelf al een voorspelling (prognose) van het totaal aantal zij instromers/uitstromers:	<ul style="list-style-type: none"> • Ja (1) • Nee (3)

<p>Indien je ‘ja’ hebt geantwoord op de vorige vraag waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Demografische ontwikkelingen (zoals nieuwbouwwijken) (1) • Contacten met andere organisaties” (1)
<p>Hoe zeker ben je van de voorspelling die je maakt:</p>	<ul style="list-style-type: none"> • 3 (1) • 2 (1)
<p>Met welke reden monitor je het marktaandeel (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Ik denk dat dit verband houdt met de algemene onderwijskwaliteit van de school (of die van scholen in de buurt) (1) • Organisatie (1) • Ik monitor deze KPI (nog) niet (3)
<p>Hoe relevant vind je het marktaandeel:</p>	<ul style="list-style-type: none"> • 4 (1) • 1 (2) • 2 (1)
<p>Ik heb er behoefte aan om een voorspelling (prognose) te hebben van het marktaandeel:</p>	<ul style="list-style-type: none"> • Eens (1) • Oneens (3)
<p>Ik heb zelf al een voorspelling (prognose) van het marktaandeel:</p>	<ul style="list-style-type: none"> • Ja (1) • Nee (3)

<p>Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Demografische ontwikkelingen (zoals nieuwbouwwijken) (1) • Aanmeldingen (1)
<p>Hoe zeker ben je van de voorspelling die je maakt:</p>	<ul style="list-style-type: none"> • 3 (1) • 1 (1)
<p>Ik vind de volgende meeteenheid voor geografische verdeling relevant:</p>	<ul style="list-style-type: none"> • Het aantal leerlingen per wijk die naar een bepaalde school gaan (en de ontwikkeling van de afgelopen jaren) (3) • Ik heb geen interesse in deze KPI (1)
<p>Met welke reden monitor je de geografische verdeling (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Ik wil weten of de keus voor basisschool te maken heeft met de wijk waarin leerlingen en hun ouders wonen (3) • Ik monitor deze KPI (nog) niet (1) • Niet zo relevant ivm dorpsschool (1)
<p>Hoe relevant vind je de geografische verdeling:</p>	<ul style="list-style-type: none"> • 3 (3) • 4 (1)
<p>Ik heb er behoefte aan om een voorspelling (prognose) te hebben van de geografische verdeling:</p>	<ul style="list-style-type: none"> • Eens (2) • Oneens (2)

Ik heb zelf al een voorspelling (prognose) van de geografische verdeling:	<ul style="list-style-type: none"> • Ja (1) • Nee (3)
Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Gegevens van geografische verdeling van voorgaande jaren (1) • Externe factoren zoals nieuwe wijken (1)
Hoe zeker ben je van de voorspelling die je maakt:	<ul style="list-style-type: none"> • 3 (1) • 1 (1)
Ik vind de volgende meeteenheid voor welzijn en tevredenheid van leerlingen relevant (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Algemene tevredenheid van leerlingen (4) • Algemene tevredenheid van ouders (4) • Algemene welzijn van leerlingen (4) • Tevredenheid van leerlingen over niet-toetsbare vaardigheden (zoals persoonlijke ontwikkeling) (4) • Tevredenheid van ouders over niet-toetsbare vaardigheden (zoals persoonlijke ontwikkeling) (4)

<p>Met welke reden monitor je het welzijn en tevredenheid van leerlingen (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Ik wil mijn leerlingen monitoren op dit gebied (1) • Ik wil weten wanneer er afwijkingen zijn (2) • Omdat ik denk dat het verband houdt met de resultaten van de leerlingen (2) • omdat het wettelijk verplicht is vanaf groep 6 (1) • Ik monitor deze KPI (nog) niet (1)
<p>Hoe relevant vind je welzijn en tevredenheid van leerlingen:</p>	<ul style="list-style-type: none"> • 5 (2) • 4 (2)
<p>Ik heb er behoefte aan om een voorspelling (prognose) te hebben van welzijn en tevredenheid van leerlingen:</p>	<ul style="list-style-type: none"> • Oneens (3) • Eens (1)
<p>Ik heb zelf al een voorspelling (prognose) van welzijn en tevredenheid van leerlingen:</p>	<ul style="list-style-type: none"> • Nee (4)
<p>Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):</p>	
<p>Hoe zeker ben je van de voorspelling die je maakt:</p>	<ul style="list-style-type: none"> • 2 (1)

Ik vind de volgende meeteenheid voor absentie relevant (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Gemiddelde absentie frequentie binnen een school (3) • Dit wordt gemonitord op schoolniveau, niet op bestuursniveau (1)
Met welke reden monitor je absentie (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Rapportage in verband met leerplicht (3) • Ik denk dat het verband houdt met het welzijn en tevredenheid van leerlingen (2) • Ik monitor deze KPI (nog) niet (1)
Hoe relevant vind je absentie:	<ul style="list-style-type: none"> • 5 (2) • 3 (2)
Ik heb er behoefte aan om een voorspelling (prognose) te hebben van absentie:	<ul style="list-style-type: none"> • Oneens (3) • Eens (1)
Ik heb zelf al een voorspelling (prognose) van absentie:	<ul style="list-style-type: none"> • Nee (3)
Indien je 'ja' hebt geantwoord op de vorige vraag waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):	
Hoe zeker ben je van de voorspelling die je maakt:	<ul style="list-style-type: none"> • 3 (1)

<p>Ik vind de volgende meeteenheid voor referenties naar speciaal onderwijs relevant (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Ik heb geen interesse in deze KPI (2) • Het totale aantal leerlingen dat in een bepaald jaar naar het speciaal onderwijs is verwezen (en dat van afgelopen jaren) (2) • De reden waarom is verwezen, onderscheid tussen sbo en so (1)
<p>Met welke reden monitor je referenties naar speciaal onderwijs (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Ik monitor deze KPI (nog) niet (1) • Ik vind dat alle kinderen een plek in de wijk verdienen op een school waar ze tot leren komen (1) • Omdat dit te maken heeft met passend onderwijs (2)
<p>Hoe relevant vind je het aantal referenties naar speciaal onderwijs:</p>	<ul style="list-style-type: none"> • 1 (1) • 4 (1) • 5 (1)
<p>Ik heb er behoefte aan om een voorspelling (prognose) te hebben van het aantal referenties naar speciaal onderwijs:</p>	<ul style="list-style-type: none"> • Oneens (1) • Eens (2)
<p>Ik heb zelf al een voorspelling (prognose) van het aantal referenties naar speciaal onderwijs:</p>	<ul style="list-style-type: none"> • Ja (2)

<p>Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • De cijfers van deze referenties naar speciaal onderwijs van de voorgaande jaren (1) • De cijfers van de referenties naar speciaal onderwijs van de voorgaande jaren (1)
<p>Hoe zeker ben je van de voorspelling die je maakt:</p>	<ul style="list-style-type: none"> • 3 (2)
<p>Ik vind de volgende meeteenheid voor herziene adviezen relevant (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Het totale aantal (groep 8) adviezen dat moet worden herzien in een jaar (en de afgelopen jaren) (3) • Het totale aantal (groep 8) adviezen dat is bijgewerkt in een jaar (en de afgelopen jaren) (3)
<p>Met welke reden monitor je het aantal herziene adviezen (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Deze KPI zegt mij iets over de kwaliteit van de adviezen (3) • Omdat ik denk dat deze KPI verband houdt met de prestatie binnen het voortgezet onderwijs (1) • Ik monitor deze KPI (nog) niet (1)
<p>Hoe relevant vind je het aantal herziene adviezen:</p>	<ul style="list-style-type: none"> • 4 (3) • 3 (1)
<p>Ik heb er behoefte aan om een voorspelling (prognose) te hebben van het aantal herziene adviezen:</p>	<ul style="list-style-type: none"> • Oneens (4)

Ik heb zelf al een voorspelling (prognose) van het aantal herziene adviezen:	<ul style="list-style-type: none"> • Nee (3)
Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):	
Hoe zeker ben je van de voorspelling die je maakt:	<ul style="list-style-type: none"> • 3 (1)
Ik vind de volgende meeteenheid voor status van het voortgezet onderwijs relevant (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Het percentage leerlingen dat op het geadviseerde niveau zit (3 jaar na het verlaten van groep 8), het percentage leerlingen dat onder het geadviseerde niveau zit en het percentage dat boven het geadviseerde niveau zit. Daarbij ook deze cijfers van de afgelopen jaren. (3) • Ik heb geen interesse in deze KPI (1) • De cijfers na 1 jr zeggen het meest, na 3 jr is er veel vervuiling, lln die op/afgestroomd zijn naar een andere school verdwijnen uit deze overzichten. Er is door de avg ook niet op individueel niveau te monitoren terwijl dat t meest zou kunnen zeggen. (1)

<p>Met welke reden monitor je status van het voortgezet onderwijs (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Deze KPI zegt iets over de kwaliteit van de adviezen (2) • Om te monitoren of de leerlingen presteren zoals verwacht (3) • Ik wil monitoren of kansrijk wordt geadviseerd (2) • Om te kijken of de school kansrijk adviseert (1)
<p>Hoe relevant vind je status van het voortgezet onderwijs:</p>	<ul style="list-style-type: none"> • 4 (2) • 3 (1)
<p>Ik heb er behoefte aan om een voorspelling (prognose) te hebben van status van het voortgezet onderwijs:</p>	<ul style="list-style-type: none"> • Oneens (2) • Eens (1)
<p>Ik heb zelf al een voorspelling (prognose) van status van het voortgezet onderwijs:</p>	<ul style="list-style-type: none"> • Nee (3)
<p>Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):</p>	
<p>Hoe zeker ben je van de voorspelling die je maakt:</p>	<ul style="list-style-type: none"> • 4 (1)

<p>Ik vind de volgende meeteenheid voor studieresultaten relevant (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Het percentage groep 8 leerlingen op 1f niveau en op 1s/2f niveau (referentieniveaus) binnen een school (per vak). Daarbij ook deze cijfers van de afgelopen jaren. (4) • De niveauwaardes voor elk vak in groep 8 binnen een school. Daarbij ook deze cijfers van de afgelopen jaren. (2) • Tussentijdse resultaten (voor groep 8) van de referentieniveaus en niveau waardes op een school. Daarbij ook deze cijfers van de afgelopen jaren. (3) • Tussentijdse toetsresultaten (inclusief groep 8) van de leerlingen op een school (2) • Vanaf groep 6 ook percentage lln dat op koers is voor de ref niveaus per vakgebied (1)
<p>Met welke reden monitor je de studieresultaten (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Om eigen gestelde doelen met betrekking tot referentieniveaus/niveauwaardes te monitoren (4) • Om de ontwikkeling van leerlingen in de gaten te houden (3) • Om te monitoren dat de signaleringswaarden niet worden behaald (bijvoorbeeld: 85% van de leerlingen moet op 1f niveau zitten) (2)
<p>Hoe relevant vind je studieresultaten:</p>	<ul style="list-style-type: none"> • 5 (2) • 4 (2)

Ik heb er behoefte aan om een voorspelling (prognose) te hebben van studieresultaten in groep 8:	<ul style="list-style-type: none"> • Eens (3) • Oneens (1)
Ik heb zelf al een voorspelling (prognose) van studieresultaten in groep 8:	<ul style="list-style-type: none"> • Ja (4)
Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Studieresultaten van eerdere jaren (bijvoorbeeld de referentieniveaus in groep 6/7) (3) • School weging (1) • LVS IEP (1)
Hoe zeker ben je van de voorspelling die je maakt:	<ul style="list-style-type: none"> • 4 (3) • 5 (1)
Ik vind de volgende meeteenheid voor verzuim relevant (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Gemiddelde verzuimduur afgelopen periode per school (1) • Meldingsfrequentie afgelopen periode per school (1) • Verzuimpercentage (actueel/gemiddeld/voortschrijdend) afgelopen periode per school (1)

<p>Met welke reden monitor je verzuim (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Ik wil zien hoe het de afgelopen jaren heeft ontwikkeld (1) • Ik wil een prognose maken over het verwachte aantal benodigde invaldocenten (1) • Het verzuim moet onder een afgesproken percentage blijven (1) • Ik wil zoeken naar de reden voor het verzuim (bijvoorbeeld een verzuimcultuur of langdurige zieken) (1) • Omdat ik denk dat het verband houdt met werknemerstevredenheid (1) • Omdat ik denk dat het verband houdt met de onderwijskwaliteit” (1)
<p>Hoe relevant vind je verzuim:</p>	<ul style="list-style-type: none"> • 5 (1)
<p>Ik heb er behoefte aan om een voorspelling (prognose) te hebben van verzuim:</p>	<ul style="list-style-type: none"> • Eens (1)
<p>Ik heb zelf al een voorspelling (prognose) van verzuim:</p>	<ul style="list-style-type: none"> • Ja (1)
<p>Indien je ‘ja’ hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • De cijfers van verzuim duur/frequentie/percentage de afgelopen jaren (1) • Gevoel (zoals het vermoeden van aanwezigheid van een verzuimcultuur) (1) • Seizoen (1)

Hoe zeker ben je van de voorspelling die je maakt:	<ul style="list-style-type: none"> • 4 (1)
Ik vind de volgende meeteenheid voor loonkosten relevant (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Totale loonkosten per periode (1) • Statistische waardes van de loonkosten (zoals gemiddelde, minimum en maximum) (1)
Met welke reden monitor je loonkosten (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Ik monitor deze KPI (nog) niet (1) • Ik wil weten hoe de begrootte loonkosten zijn ten opzichte van de werkelijke loonkosten” (1)
Hoe relevant vind je loonkosten:	<ul style="list-style-type: none"> • 4 (1)
Ik heb er behoefte aan om een voorspelling (prognose) te hebben van loonkosten:	<ul style="list-style-type: none"> • Eens (1)
Ik heb zelf al een voorspelling (prognose) van loonkosten:	<ul style="list-style-type: none"> • Nee (1)
Indien je ‘ja’ hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):	
Hoe zeker ben je van de voorspelling die je maakt:	<ul style="list-style-type: none"> • 3 (1)

<p>Ik vind de volgende meeteenheid voor beschikbaar FTE relevant (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Totaal aantal FTE beschikbaar per maand (of andere periode) op een school (1) • Totaal aantal werknemers beschikbaar per maand op een school (1) • Het aantal leraren ten opzichte van leerlingen op een school (1) • Gemiddelde groepsgrootte van een school (1) • Gemiddeld aantal FTE beschikbaar per team (1) • Gemiddelde dienstbetrekking omvang (1)
<p>Met welke reden monitor je beschikbaar FTE (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Ik wil weten hoeveel werknemers verantwoordelijk zijn voor een leerling en of er genoeg geïnvesteerd kan worden in een kind (1) • Ik wil weten of ik mijn leraren kan motiveren om meer te werken als de gemiddelde dienstbetrekking omvang laag is (1)
<p>Hoe relevant vind je beschikbaar FTE:</p>	<ul style="list-style-type: none"> • 4 (1)
<p>Ik heb er behoefte aan om een voorspelling (prognose) te hebben van beschikbaar FTE:</p>	<ul style="list-style-type: none"> • Eens (1)
<p>Ik heb zelf al een voorspelling (prognose) van beschikbaar FTE:</p>	<ul style="list-style-type: none"> • Nee (1)
<p>Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):</p>	

Hoe zeker ben je van de voorspelling die je maakt:	<ul style="list-style-type: none"> • 4 (1)
Ik vind de volgende meeteenheid voor studenten op de lerarenopleiding relevant (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Het totaal aantal huidige studenten op de lerarenopleiding (1) • De instroom en uitstroom afgelopen jaar van de lerarenopleiding (1)
Met welke reden monitor je het aantal studenten op de lerarenopleiding (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Ik wil weten of er de komende jaren voldoende personeel beschikbaar komt (1)
Hoe relevant vind je het aantal studenten op de lerarenopleiding:	<ul style="list-style-type: none"> • 5 (1)
Ik heb er behoefte aan om een voorspelling (prognose) te hebben van het aantal studenten op de lerarenopleiding:	<ul style="list-style-type: none"> • Eens (1)
Ik heb zelf al een voorspelling (prognose) van het aantal studenten op de lerarenopleiding:	<ul style="list-style-type: none"> • Ja (1)
Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):	
Hoe zeker ben je van de voorspelling die je maakt:	<ul style="list-style-type: none"> • 4 (1)

<p>Ik vind de volgende meeteenheid voor personeel welzijn en tevredenheid relevant (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Het aantal werknemers tevredenheidsonderzoeken afgelopen jaar per school (1) • Het gemiddelde aantal ontwikkelgesprekken van de werknemers per school (1) • Resultaten van een (kwaliteit)vragenlijst (1) • eNPS (1) • (employee) Net Promotor Score (1)
<p>Met welke reden monitor je personeel welzijn en tevredenheid (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Het geeft inzicht in het leiderschap niveau van de school (1) • Om te kijken of leraren tevreden zijn over de school als werkgever (en dus kunnen optreden als ambassadeur) (1) • Omdat ik denk dat het verband houdt met de resultaten van de leerlingen (1) • Omdat ik denk dat het verband houdt met het welzijn en geluk van de leerlingen (1)
<p>Hoe relevant vind je personeel welzijn en tevredenheid:</p>	<ul style="list-style-type: none"> • 4 (1)
<p>Ik heb er behoefte aan om een voorspelling (prognose) te hebben personeel welzijn en tevredenheid:</p>	<ul style="list-style-type: none"> • Eens (1)
<p>Ik heb zelf al een voorspelling (prognose) van personeel welzijn en tevredenheid:</p>	<ul style="list-style-type: none"> • Ja (1)

<p>Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • De cijfers van personeel welzijn en tevredenheid van de afgelopen jaren (1)
<p>Hoe zeker ben je van de voorspelling die je maakt:</p>	<ul style="list-style-type: none"> • 4 (1)
<p>Ik vind de volgende meeteenheid voor personeelsverloop relevant (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Totaal aantal nieuwe werknemers binnen een bepaalde periode (1) • Totaal aantal werknemers dat is weggegaan binnen een bepaalde periode (1) • De redenen voor de werknemers die zijn weggegaan (1) • Het verlooppercentage van een bepaalde periode (1) • Percentage werknemers dat binnen 2 jaar weg gaat (1)
<p>Met welke reden monitor je personeelsverloop (meerdere antwoorden mogelijk):</p>	<ul style="list-style-type: none"> • Ik wil weten hoe de organisatie het doet als werkgever (1) • Ik wil weten wat de belangrijkste redenen zijn voor vertrek (zoals pensioen) (1) • Omdat ik denk dat het verband houdt met werknemer tevredenheid en welzijn (1) • Omdat ik denk dat het verband houdt met de onderlinge verbondenheid van de werknemers (1) • Omdat ik denk dat het verband houdt met leerlingresultaten (1)

Hoe relevant vind je personeelsverloop:	<ul style="list-style-type: none"> • 4 (1)
Ik heb er behoefte aan om een voorspelling (prognose) te hebben van personeelsverloop:	
Ik heb zelf al een voorspelling (prognose) van personeelsverloop:	
Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Personeelsverloop van de afgelopen jaren (1) • Investerings in opleidingen voor het personeel (1) • Leeftijd (in verband met pensioen) (1) • Benchmarkcijfers (bijvoorbeeld: gemiddeld x% van het personeel verlaat de organisatie binnen een maand voor een andere werkgever) (1) • Externe factoren zoals het lerarentekort (veel concurrerende werkgevers)" (1)
Hoe zeker ben je van de voorspelling die je maakt:	<ul style="list-style-type: none"> • 4 (1)
Ik vind de volgende meeteenheid voor functie doorstroom relevant (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Het aantal geregistreerde functiewisselingen op een school (1) • Het percentage (en totale aantal) van personeel dat van OOP (onderwijs ondersteunend personeel) naar OP (onderwijsgevend personeel) gaat op een school (1)

Met welke reden monitor je functie doorstroom (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Ik monitor deze KPI (nog) niet (1) • Ik wil weten op welke scholen er (genoeg) doorgroeimogelijkheden zijn (1) • Ik wil carrière paden creëren op scholen om meer personeel te krijgen (1) • Omdat ik denk dat het verband houdt met verbondenheid van het personeel (1)
Hoe relevant vind je functie doorstroom:	
Ik heb er behoefte aan om een voorspelling (prognose) te hebben van functie doorstroom:	<ul style="list-style-type: none"> • Eens (1)
Ik heb zelf al een voorspelling (prognose) van functie doorstroom:	<ul style="list-style-type: none"> • Nee (1)
Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk)	
Hoe zeker ben je van de voorspelling die je maakt:	<ul style="list-style-type: none"> • 4 (1)
Ik vind de volgende meeteenheid voor werkdruk relevant (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Hoeveelheid verwachte taken in FTE ten opzichte van het beschikbare FTE (1)
Met welke reden monitor je werkdruk (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Om te monitoren of er genoeg personeel in huis is om alle taken te volbrengen (1) • Ik monitor deze KPI (nog) niet (1)

Hoe relevant vind je werkdruk:	<ul style="list-style-type: none"> • 4 (1)
Ik heb er behoefte aan om een voorspelling (prognose) te hebben van werkdruk:	<ul style="list-style-type: none"> • Eens (1)
Ik heb zelf al een voorspelling (prognose) van werkdruk:	
Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Leerlingaantallen (1) • Werkdruk van de afgelopen jaren (1)
Hoe zeker ben je van de voorspelling die je maakt:	<ul style="list-style-type: none"> • 3 (1)
Ik vind de volgende meeteenheid voor ontwikkeling / verdere training personeel relevant (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Hoeveel tijd wordt er gespendeerd per werknemer aan verdere training/ontwikkeling (cijfers zoals gemiddelde, minimum en maximum) (1) • Percentage van salariskosten uitgegeven aan verdere training/ontwikkeling (1)
Met welke reden monitor je ontwikkeling van personeel (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Om te meten of er genoeg tijd wordt besteed aan verdere ontwikkeling (1) • Omdat we streven naar duurzame inzetbaarheid (1) • Omdat ik denk dat het verband houdt met personeelsverloop (1)

Hoe relevant vind je ontwikkeling van personeel:	<ul style="list-style-type: none"> • 4 (1)
Ik heb er behoefte aan om een voorspelling (prognose) te hebben van ontwikkeling van personeel:	<ul style="list-style-type: none"> • Eens (1)
Ik heb zelf al een voorspelling (prognose) van ontwikkeling van personeel:	<ul style="list-style-type: none"> • Nee (1)
Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Cijfers van personeel ontwikkeling afgelopen jaren (1) • Cijfers van personeelsverloop (1)
Hoe zeker ben je van de voorspelling die je maakt:	<ul style="list-style-type: none"> • 4 (1)
Ik vind de volgende meeteenheid voor zij-instroom (Werknemers die beginnen en starten aan PABO) relevant (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Totale aantal van zij-instromers dat blijft na afronden van opleiding (1) • Percentage van zij-instromers dat blijft na afronden van opleiding (1)
Met welke reden monitor je zij-instroom (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Omdat ik wil weten of het de investering waard is (1)
Hoe relevant vind je zij-instroom:	<ul style="list-style-type: none"> • 4 (1)
Ik heb er behoefte aan om een voorspelling (prognose) te hebben van zij-instroom:	<ul style="list-style-type: none"> • Eens (1)

Ik heb zelf al een voorspelling (prognose) van zij-instroom:	<ul style="list-style-type: none"> • Nee (1)
Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Personeel tevredenheid en welzijn (1) • Cijfers van zij-instroom van de afgelopen jaren (1)
Hoe zeker ben je van de voorspelling die je maakt:	<ul style="list-style-type: none"> • 4 (1)
Ik vind de volgende meeteenheid voor verdeling personeel relevant (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • De verdeling van het personeel gebaseerd op geslacht per school (1) • De verdeling van het personeel gebaseerd op leeftijd per school (1) • De verdeling van het personeel gebaseerd op per functie/functiegroep (1) • Ik zou graag voor alle eerder genoemde KPIs een verdeling willen zien gebaseerd op geslacht/leeftijd/functie per school (1) • De verdeling van het personeel gebaseerd op specialisme per school (indien aanwezig) (1)
Met welke reden monitor je verdeling personeel (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Ik vind diversiteit onder de werknemers belangrijk (1) • Ik wil voldoende specialisme op een school (1)

Hoe relevant vind je verdeling personeel:	<ul style="list-style-type: none"> • 4 (1)
Ik heb er behoefte aan om een voorspelling (prognose) te hebben van verdeling personeel:	<ul style="list-style-type: none"> • Eens (1)
Ik heb zelf al een voorspelling (prognose) van verdeling personeel:	<ul style="list-style-type: none"> • Nee (1)
Indien je 'ja' hebt geantwoord op de vorige vraag, waarop baseer je deze voorspelling (meerdere antwoorden mogelijk):	<ul style="list-style-type: none"> • Externe factoren zoals de economische staat van het land (1) • Cijfers van verdeling personeel van de afgelopen jaren (1)
Hoe zeker ben je van de voorspelling die je maakt:	<ul style="list-style-type: none"> • 4 (1)

Table C.1