Dashboards have long been used in business and engineering fields to provide users with a consolidated view of data to inform decision making. These decision makers are most often experts in their profession (for example, sales managers in business or pilots in engineering), who bring their expertise into the process of interpreting the data provided through the dashboard view. Dashboards are designed to use data to communicate information about areas that may need attention and action (Few, 2013). The rise of ‘big data’ across many industries has prompted new and innovative approaches to bringing together and displaying this data in ways that are meaningful and informative. With increasing amounts of data being collected about students’ behaviour in learning environments, it is therefore not surprising that the idea of building dashboards to provide an overview of student progress and performance has also become popular in education, sparking a range of dashboard development for students across all stages of education.

In the educational context, learning dashboards have been defined as: ‘a single display that aggregates different indicators about learner(s), learning process(es) and/or learning context(s) into one or multiple visualisations’ (Schwendimann et al., 2017). While the majority of dashboards developed in education initially focused on providing information to teachers and administrators, an increasing number of student-facing dashboards are starting to emerge. For students, dashboards provide an opportunity to gain feedback on their learning activities and assessments, providing evidence to inform decisions around how they approach their study. Many universities, schools, learning management system vendors, and other educational technology companies are currently exploring innovative ways to deliver interactive dashboards to students which incorporate useful information displayed in ways that are easily interpretable by students.

However, there is an emerging concern about students’ ability to interpret the data provided in dashboards in a way that is beneficial to their learning (Clow, 2013; Corrin & de Barba, 2014; Teasley, 2017). Research into student dashboards, to date, has tended to focus on measuring an increase in grade or a decrease in attrition in cohorts of students who have had access to a dashboard (Arnold & Pistilli, 2012). Other studies have sought students’ opinions about what
they would like to see in a dashboard prior to design and development (Roberts, Howell, Seaman, & Gibson, 2016), or evaluated student satisfaction with dashboards once they have been implemented (Govaerts, Verbert, Duval, & Pardo, 2012). However, fewer studies have examined students’ interpretation of dashboards and the actions they take as a result of exposure to this feedback in detail. Understanding the ways that students interact with and interpret data provided by interactive dashboards is vital in order to design effective dashboards that can support student learning. Consequently, the development of more sophisticated ways of evaluating students’ interpretation of feedback delivered via dashboards is required. In establishing ways to improve evaluation it is wise to draw on tested and established practices from fields such as score reporting to inform the ways such evaluation is undertaken.

This chapter explores the role of interactive dashboards in educational environments and ways in which students’ interpretation of feedback delivered through dashboards can be evaluated. This investigation is guided by the following questions:

1. What are the key design considerations and evaluation approaches used when developing learning analytics dashboards to provide feedback to students?
2. What lessons can be learnt from the score reporting literature that can guide the design and evaluation of learning analytics dashboards for students?

The chapter will also include two case studies of student-facing dashboards and the ways that students’ interpretation of these dashboards have been evaluated. The chapter concludes with a discussion of the importance of considered design of dashboards that link representations of feedback to educational theories and the design of learning and assessment activities. The ways that support for student interpretation of dashboards can be delivered will also be discussed, including how approaches and principles from the score reporting literature can be used to guide the development of such support mechanisms.

Background

A decade ago the field of learning analytics emerged as the use of technology in education became more widespread and researchers began to recognise the value in the data automatically generated and collected by such technologies. The Society for Learning Analytics Research (SoLAR) was subsequently established in 2012 and define learning analytics as: ‘the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs’. Research and development in the field has grown exponentially over the past few years to encompass a wide range of contexts, tools, frameworks, and issues. A key strength of the learning analytics community is that it brings together researchers and developers from across multiple disciplines including education, learning sciences, computer science, and psychology. This wealth of perspectives and knowledge offers great potential for the development of powerful tools and approaches to support and enhance student learning.

Amongst the wide range of learning analytics tools and techniques that have emerged, the idea of creating dashboards of data has featured prominently. This idea has appealed strongly, not only to learning analytics researchers, but also to educational institutions and educational technology vendors. The utilisation of dashboards is seen as a way to harness the huge amounts of data available from learning technologies and make this data accessible to those who can make best use of it. The majority of learning analytics dashboards currently in use primarily focus on providing data to teachers and educational administrators. A recent study of 55 learning dashboard projects found that 75% of dashboards were aimed at teachers, while 51%
were aimed at students (25% provided data for both students and teachers) (Schwendimann et al., 2017). A predominant focus of these systems has been to identify individuals or groups of students who are ‘at risk’ of either low performance or failure. Many of the student-facing dashboards available focus on providing students ways of seeing whether they are at risk in relation to a single task or across a course of study.

One of the earliest and most well-known examples of this form of retention-focused student dashboard is the Course Signals system which was implemented in 2007 at Purdue University (Arnold & Pistilli, 2012). This system’s dashboard used a traffic light visualisation scheme to indicate a level of risk for students at different points throughout the semester (red = high risk, yellow = moderate risk, green = low risk). The colours of the traffic lights are determined by a predictive algorithm which incorporates data on student marks, interaction with the learning management system, prior academic history, and student demographics (e.g., age, residency, enrolled credits). In addition to the dashboard, the Course Signals system was designed to allow teachers to implement appropriate intervention strategies for students such as sending emails/text messages or scheduling face-to-face meetings to discuss the risk to a student’s performance. Students also had the ability to click on their traffic light colour and receive a list of resources that can help them in their course. Early evaluation of the Course Signals system through surveys and focus groups found that most students (88%) reported a positive experience of interacting with the system. The evaluation of the dashboard focused on measuring changes in performance, retention and students’ self-reports of motivation taken at the end of the semester (Pistilli, Arnold & Bethune, 2012). However, subsequent analysis of the data has raised concerns about some of the findings of this evaluation due to the reverse-causality effect (Caulfield, 2013). This example highlights the importance of careful evaluation design in measuring impacts of learning analytics-based systems, including dashboards.

Over time, many different forms of student-facing dashboard have been developed to address a range of different purposes. From helping students to monitor their activity and performance to providing evidence to promote self-reflection, dashboards have been built around a desire to allow students to view their own data in order to promote sense-making. Recently a number of systematic reviews of learning analytics dashboard design have been conducted on both teacher- and student-facing dashboards (Verbert et al., 2014; Yoo, Lee, Jo, & Park, 2015; Bodily & Verbert, 2017; Jivet, Scheffel, Drachsler, & Specht, 2017; Schwendimann et al., 2017). These reviews have explored the purpose, design, and evaluation of dashboards in order to provide guidance on how dashboards can be designed effectively and used to support student learning. The next section of this chapter will explore the outcomes of these reviews in relation to the first research question: What are the key design considerations and evaluation approaches used when developing learning analytics dashboards to provide feedback to students?

Designing and Evaluating Learning Dashboards

The Verbert et al. (2014) review examined 24 papers on dashboards with 14 focused on student dashboards. The review profiled the type of user actions that were represented in the dashboards including artefacts produced, social interactions, time spent on tasks, resource use and activity/assessment results. Of the 14 student-focused dashboards examined in the study, only 10 reported details about the evaluation undertaken. These evaluations focused on the perceived usefulness, usability and effectiveness (including student satisfaction) of the dashboards. It was observed that the results of these evaluations were mixed depending on the dashboard purpose and the data included in the dashboard design. While some studies had reported an increase in grades, retention and self-assessment, others showed no significant difference in these areas. It was concluded that there was limited consensus across the studies as to the most relevant data to
be included in dashboards and that more research is needed to consider what other data about learners and the learning process could be useful. It is also suggested that more longitudinal approaches to evaluating the impact of dashboards on student learning are required.

The review conducted by Yoo et al. (2015) focused on educational dashboards based on data from learning management systems. 10 dashboards were included in the review with seven of these having a student-facing component. The information presented in these dashboards included login trends, performance results, content usage, message analysis, online social networks, and at-risk student prediction. The review applied Kirkpatrick and Kirkpatrick's (2006) four level evaluation model (reaction, learning, behaviour and result) to each of these 10 dashboards to assess the evaluation conducted on each. Only six of the 10 dashboard studies were found to have addressed any of the four levels, with only one dashboard study (Upton & Kay, 2009) fully evaluating each of the four levels. Yoo et al. (2015) then went on to propose an evaluation framework for educational dashboards which brings together Kirkpatrick's four level model (Kirkpatrick & Kirkpatrick, 2006), Verbert et al.'s (2013) learning analytics process model (impact, sense-making, reflection and awareness), and Few's (2009) blocks of information visualisation (see Table 10.1).

The systematic review conducted by Schwendimann et al. (2017) incorporated studies of 55 dashboards, of which 28 were student-facing. They identified six forms of data included in the dashboard designs (activity logs, learning artefacts, self-report data, institutional databases, physical activity and external systems) and 200 individual indicators, which they categorised by how each related to the learner, action, content, results, social or context. Over half (58%) of the studies didn't contain any evaluation, but of those studies that did contain evaluation 65% involved a mixed methods approach which combined quantitative and qualitative techniques. The evaluations tended to focus on usability, usefulness and user satisfaction, with very few exploring the impact of the dashboards on learning. The review authors observed that most evaluation methods appeared to be 'low-effort, low-detail' (p. 38) and called for more comparative studies of dashboards, indicators, visualisations and impact.

The review by Bodily and Verbert (2017) broadened out the inclusion criteria to look not just at student dashboards, but any form of student-facing analytics output. The review included 94 articles covering student-facing learning analytics reporting systems designed for the purposes of awareness/reflection, recommendation of resources, improvement of retention or engagement, increasing social behaviour online, and recommendation of courses. Of the 94 systems reviewed only 29 provided any interactive elements for students and very few (12) provided

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justifications for the design choices made in relation to the dashboard design. In terms of evaluation, 10 articles included some form of usability testing, 32 sought student perceptions of usability, 34 looked at usefulness and 35 asked students if they perceived a change in behaviour, achievement or skills. The review concluded with a list of recommendations for implementing reporting systems which can also be used to provide a good structure for evaluating student-facing dashboards. These include questions on intended goals, visualisation techniques, information selection, needs assessment, usability testing, visual design, student perceptions, actual effects, and student use.

The most recent published review of learning analytics dashboards was conducted by Jivet et al. (2017) and focused on how theories and models from the learning sciences have been used to inform the design of dashboards. From an initial sample of 95 papers that reported on student-facing dashboards, widgets or visualisations, the authors identified 26 of these studies that met the further criteria of being empirical and relying on educational concepts in their design. Across the included dashboards six educational concepts were identified: cognitivism, constructivism, humanism, descriptive models, instructional design, and psychology. The most common goal of student-facing dashboards was to support awareness and reflection which, along with improving metacognitive skills, monitoring progress and supporting planning, were classified as relating to metacognitive competence. The other three competences identified were cognitive, behavioural and emotional. Each of these competencies relate to the core theory of self-regulated learning and the review authors suggest that dashboards should be complemented with tools that can help students who are struggling with their self-regulation to develop their skills. This review also raised the concern of the common use of student comparisons in dashboards and suggests that using goal achievement as a standard for comparison could be a more pedagogically-sound approach than creating competition among students. Unlike the previous reviews, the Jivet et al. (2017) review didn't specifically investigate evaluation of dashboards, but did make a recommendation that evaluation should be linked to the educational concepts that inform the dashboard design.

While each of the reviews included here had a slight different focus or sample, a number of consistent themes emerged. The reviews showed that there are many different ways of designing dashboards and many different purposes for which dashboards can be used. However, the details in the literature about theoretical foundations, design considerations and data specifications were varied or, in some cases, missing. This makes it difficult to determine whether these elements were considered and just not reported, or whether they weren’t part of the dashboard design process. In their review, Schwendimann et al. (2017) provide a checklist of elements that they recommend be included when reporting on dashboard project. In practice, this list can also be used as a checklist for the process of dashboard design. The checklist includes having a clear definition of learning dashboards, outlining the technologies used, the educational context, the evaluation approach (including how learning impacts were evaluated), and the resulting learner/teacher practices (Schwendimann et al., 2017). Two additions to this list can be made from suggestions from the Bodily and Verbert (2017) review, including a needs assessment prior to design and development, and a justification of the visual techniques chosen to represent the data in the dashboard.

It should also be noted that two critical challenges were raised in the dashboard reviews that need to be addressed by dashboard designers in order for dashboards to be effective in educational environments. The first of these are the ethical and privacy considerations around the use of student data to populate learning dashboards. Much has been written about the need for strong ethical frameworks to guide educational institutions on the protection of students’ privacy when developing learning analytics systems (Slade & Prinsloo, 2013; Sclater, 2014). It is also imperative for the student voice to be included in discussions around the use of their data.
Recently several studies have emerged that have involved students in discussions around their willingness to share their data for the purposes of building learning analytics tools such as dashboards (Brooker, Corrin, Mirriahi, & Fisher, 2017; Roberts et al., 2016). While many schools and universities have started to implement processes to protect and make ethical use of student data, there is still some way to go in ensuring this protection is universal.

The second challenge focuses on the emphasis some dashboard designs place on allowing students to compare their engagement and/or performance with their peers. The inclusion of comparative elements, such as a class average, is common in learning dashboard design, especially in dashboard products developed by educational technology vendors. However, the literature on social comparison theory (Festinger, 1954), motivation (Pintrich, 2004), and self-regulation (Butler & Winne, 1995) suggest that these comparative elements can have different effects on different students. This is an area that requires more research to determine how this can best be approached in terms of dashboard design. This should include studies in real educational environments over time to see, not only the short term effects on students' engagement with a single task or subject, but also how this impacts the ways students approach their study going forward.

Approaches to the evaluation of the impact dashboards vary across the literature. Perhaps the most surprising outcome from the dashboard reviews was the fact that many studies either do not undertake evaluation or, if they do, do not report the evaluation outcomes in their work. Of those papers that did report evaluation findings, the main areas of evaluation focused on usability, usefulness, satisfaction, and effectiveness. While the issues of usability, usefulness, and satisfaction are all very important in ensuring that dashboards are designed well, the issue of effectiveness is key to determining whether dashboards are a good mechanism for delivering feedback to students. In the Verbert et al. (2014) study, measures of effectiveness were said to include higher levels of engagement, higher performance in assessment, increased student retention, and improvements in self-assessment. Interestingly, no clear pattern of increase in these measures was seen across the studies in the dashboard review. In fact, several studies that measured changes in engagement or performance found no significant change (e.g., Morris, Piper, Cassanego, & Winograd, 2005). So, despite the fact that students are generally happy to receive data and feedback via dashboards, there is inconsistent evidence about the impact these dashboards are having on student learning.

**Evaluation of Students' Interpretation of Dashboard Feedback**

Evaluation of students’ interpretation of the feedback delivered through learning dashboards remains limited in the learning analytics literature. The ability to conduct this form of evaluation faces two main challenges. The first is to be able to gather data from students at the moment they interact with the dashboard, to understand how they translate what they are seeing through the data visualisations into some form of action. The second challenge is to be able to track whether the student follows through with this action and what impact this has on their learning. The ability to measure these two things often goes beyond what is currently captured in online systems and requires additional data collection, such as student self-report data.

To evaluate students’ interpretation of feedback delivered through dashboards it is important to underpin the evaluation process with a strong theoretical framework. This can help to guide the evaluation design and identify the evidence required to determine how feedback was interpreted by students, and also what actions resulted from this interpretation. When evaluating dashboards, it is not always possible to measure the impact on student learning directly, as changes in learning performance can be influenced by many other factors in the educational environment. However, evaluation can be targeted at investigating the extent to which the purpose of the dashboard has been achieved, for example, the impact that a dashboard has had on
students’ ability to self-regulate their learning. The following two case studies demonstrate different approaches that have been taken to evaluating students’ interpretations of dashboard visualisations and the impact these interpretations have had on students’ approaches to their study.

Case Study 1: Learning Analytics Visualisations for a Single Task

The first study by Beheshitha, Hatala, Gašević, and Joksimović (2016) was designed to investigate the effect of students’ access to learning analytics visualisations on learning activity while controlling for the motivational construct of achievement goal orientation. Situated in an authentic learning context in higher education, students were part of an experimental condition where they were shown one of three dashboard-style visualisations of their activity in an asynchronous online discussion. The three visualisations showed the student their activity in relation to either the class average for posts, the top five contributors, or the number of key concepts included in posts. Log data was collected on the visualisation views and posted messages in the learning management system. This was supplemented with a self-report survey using Elliot, Murayama, and Pekrun’s (2011) 3 x 2 achievement goal model to measure students’ goal orientation. The analysis in this study involved discourse analysis of the discussion posts (using Coh-Metrix) and hierarchical linear mixed models for the statistical analysis of the variables from across the data sources.

The results of the study showed different impacts on students’ activity as a result of viewing different visualisations. For example, students with interpersonal achievement goals (i.e., a preference to compare their work to the standard of others) who viewed the top contributors or key concepts visualisations subsequently went on to post more. Whereas, those who had viewed the class average visualisation posted less. In relation to the content of discussion posts, students with a self-avoidance goal orientation (i.e., a motivation to avoid doing the task worse than their own previous work) had higher levels of narrativity, deep cohesion, syntactic simplicity, and referential cohesion in their posts after viewing the key concepts visualisations, but not when viewing the class average or top contributors’ visualisations.

This study highlights the complexity of designing learning dashboards for students who may have different motivations and goals for their study. Methodologically, this study demonstrated a quantitative approach to measuring changes in students’ approaches to a learning task. The ability to control for different achievement goal orientations provided a more sophisticated view of the impact of learning analytics visualisations on student behaviour and engagement with a task. The authors of the study suggest that further research involving other theoretically-informed constructs could help to build a more complete picture of the impact of dashboards and visualisations on student approaches to learning.

Case Study 2: Learning Analytics Dashboard for Multiple Assessments and Tasks

In contrast to the first study, the second case study employed a more qualitative approach to exploring students’ interpretation of feedback delivered via a learning analytics dashboard (Corrin & de Barba, 2014, 2015). The study used a semester-long, multi-phase, mixed methods approach to explore higher education students’ interpretation of dashboard data and the actions they took in response, with reference to their self-regulated learning. The dashboard that was used as part of this study was built to replicate the common ways of displaying student data used by learning management system vendors. Although the dashboard wasn’t live, it contained real data of participants’ activities and performance. The 24 student participants were recruited from across two discipline areas (science and languages). At the beginning of the semester the participants were asked to fill in a survey about their personal learning goals and motivations. This was followed
by an interview in week six of semester where students were shown their dashboard and, using a think-aloud method, asked to explain their interpretation of the data visualisations. The students were also asked to outline any actions they might take as a result of seeing this data. A similar interview then took place in week 11 where students were first asked to describe how seeing the data in the previous interview had impacted their approaches to study, before going through the same think-aloud process after seeing their updated dashboard. At the end of the semester, once they had received their final grade for the subject, students were asked to fill in another survey to reflect on the impact that having this feedback had on their study throughout the semester. The survey also included questions about the usefulness of the visualisations in the dashboard.

The outcomes of the research showed a diversity in how students interpreted the dashboard data and their ability to determine suitable actions to take in response. While the dashboard designs incorporated visualisations of both activities in the LMS and results from assessment tasks (see Figure 10.1), students focused primarily on the representation of summative assessment items. Some students were able to associate the effort they put into a learning activity or assessment with the results shown in the dashboard, while others struggled to work out what they needed to do in order to improve their performance. An aspect of the dashboard design that participants found useful was the fact that all the assessment and online learning activities were shown in one consolidated view. Effectively the dashboard acted as a map of the activities and assessments that students needed to complete throughout the semester. Students were able to use the dashboard layout and feedback provided to plan their study schedules and identify tasks that they may have missed.

For each of the assessment tasks and the learning management system access statistics a class average was given as a standard for comparison. The ability to see their activity in relation to the average had a range of impacts on students depending on their different motivations and goals. Those whose performance sat below the class average tended to feel it wasn’t useful to compare their work with others. Those substantially higher than the class average reported that it was good to know that their work was of high standard, but that the average did not influence their actions going forward. Those students whose performance was close to the class average either were happy that their work was comparable with others or saw this as a motivation to try harder. Interestingly, some of these students who were happy with their average-level performance and didn’t see a need to change their study strategies, had expressed a higher performance goal at the beginning of the semester. What this meant was that by seeing their average performance on the dashboard they had been distracted from their original goal. While this is only a small study with a small sample, this particular finding indicates that more research is required to determine the broad influence of these comparative standards on students’ interpretation of dashboard feedback and motivation.

Both these case studies highlight that there are many individual differences in how students approach their studies that can impact the interpretation they make of feedback delivered via learning analytics dashboards or visualisations. Another strong theme that emerged from these two studies was the importance of the pedagogical design of learning tasks and assessments in how students interpret the visualised feedback. While the students may know the process, they followed to complete a learning or assessment task, this doesn’t always translate into a strong understanding of the pedagogical intent behind the task, which is important in helping students to identify appropriate actions to take to improve their performance. These studies also demonstrate that in order to gain a fuller understanding of the impact of dashboards on student interpretation research needs to go beyond a single data source (e.g., the log data from a learning management system) to incorporate multiple methods of data collection.

Emerging research into student dashboards has begun to uncover many issues that dashboard designers and teachers need to take into consideration when designing and implementing
dashboards in a way that can enhance the learning experience for students. Like any new field, there is still lots to learn and the popularity of this form of feedback provision will hopefully inspire more research in this area. It is also important to look to other fields where the use of dashboards and reporting of educational data are more established. Once such area is that of score reporting. Consideration of existing research on score reporting is rare in the learning analytics literature. The next section of this chapter explores what lessons can be learnt from the score reporting literature to guide the design and evaluation of learning analytics dashboards for students.
Lessons From the Field of Score Reporting

The field of score reporting has a long history of exploring effective ways to communicate information about student learning and the impact of the curriculum to students, teachers, parents, and educational administrators (Ryan, 2006). The design and evaluation of score reports are
often guided by national standards. For example, in the United States the American Educational Research Association, American Psychological Association, and the National Council on Measurement in Education work in partnership to produce the Standards of Educational and Psychological Testing. These standards address issues such as the validity, reliability, and fairness of testing and the reporting of testing scores.

Particularly relevant to the area of student dashboards is the requirement in the standards for score reports to be accompanied by supporting documentation that help the report audience to interpret the contents of the report. Across the reviews of learning analytics dashboards very little mention was made of supporting resources for interpretation of dashboard visualisations. Some dashboards were designed with the explicit purpose to be used in conversation between student and teachers or academic advisors (e.g., Aguilar, Lonn & Teasley, 2014), but many were designed to promote student self-reflection. The fact that these dashboards are commonly delivered online and accessible at any time would suggest that support for interpretation should be built into the dashboard itself (or available in a linked resource) rather than being reliant on conversations with teaching staff. While some support for interpretation can be built into the visualisation itself, information about the design of the learning and assessment activities should also be provided. As seen in the two case studies above, an understanding the pedagogical context of the data presented in dashboards is vital to the process of making an interpretation.

In relation to the validity and design of score reports, several large reviews of practice have been conducted which set forward recommendations for the design of score reports. Hattie (2009) proposes 15 principles to maximise the ability of the reader to make appropriate interpretations. These principles address the validity of score reports by suggesting that there should be minimal use of numbers and an effort made not to make the interface too cluttered. It is suggested that each report should have a theme and should be designed to answer specific questions. Among the principles are suggestions for support materials that provide a justification for the assessment design. Hattie also calls for evidence to demonstrate how audiences interpret the reports, in particular, an exploration of what the audience sees and what action they will take next. Similar themes were observed in a review by Goodman and Hambleton (2004) who also provide more specific recommendations on the visual design elements of score reports, such as the grouping of data in meaningful ways and the highlighting of main findings using boxes and graphics. The value of piloting reports is also included as a recommendation of this review. In this volume, Tannenbaum adds to the discussion around validity by setting forward strategies for alignment between assessment and score reports, design decision-points, and steps for report development. The useful perspective provided around setting the criteria for inclusion of data in a report can be used to inform how criteria could be set for the inclusion of data in a dashboard, with particular reference to whether the purpose of the dashboard is summative or formative in nature.

Further recommendations for the delivery of online static and interactive scores reports are provided by Zenisky and Hambleton (2012b). The online format provides opportunities to allow users to take more control over their exploration and interpretation of score reports through the use of links and subpages to provide more detail about the data presented. The online and interactive nature of student dashboards can also provide this opportunity, yet to date few dashboards have been built in a way that provides this functionality to students. In a recent study of student perspectives on technology-supported feedback several participants expressed a desire to be able to drill down into more detail about the concepts, competencies or skills they need to focus on to improve their assessment performance (Corrin & de Barba, 2018). In the way that subscores can provide a more detailed picture of areas in need of development in score reports, the ability to classify assessment questions in terms of areas of knowledge or skill could help students to better interpret the marks and grades they can view through dashboards so they can
determine appropriate actions to take. Yet the challenge, particularly in the more generic dashboards being delivered through learning management systems, is to get teachers to perform this classification and for adequate testing of subscores to be undertaken (SinhaRay, 2010). It is also necessary for the dashboard to support the functionality of classification and the interactivity of drilling down to see this greater level of detail.

The models of evaluation used to test interpretations of score reports prior to and post release have the potential to provide useful guidance to designers of student dashboards. A research-based model outlined by Zapata-Rivera and VanWinkle (2010) involves the gathering of assessment information needs, the reconciliation of these needs with the score reporting needs, the design of a score report prototype, an internal evaluation (with experts in subject matter, usability, measurement and accessibility), and an external evaluation (with representatives of the intended audience). Iterations of these steps can be taken as many times as needed to develop the most useful score report. Similarly, Zenisky and Hambleton’s (2012a) score report development model advocates field testing with potential user groups in controlled studies as well as the development of programmes of ongoing monitoring and maintenance. It is also important that the evaluation extends beyond the score reports themselves to the interpretation support materials created. For example, Zapata-Rivera, Zwick and Vezzu (2016) conducted an evaluation of the usefulness of a tutorial designed to help teachers to understand representations of measurement error in score reports. In addition to questions about usability, the participants were asked to complete a comprehension questionnaire to assess their understanding of the concepts covered. The development of similar instruments to investigate students’ interpretation of dashboard visualisations, and any supporting materials could be useful for dashboard design and delivery.

Conclusion

Research into student-facing analytics feedback is still in its early days and the literature on student dashboards is currently not mature enough to be able to provide authoritative guidance on the most effective visual elements to assist student learning. However, major themes are emerging around the importance of the theoretical foundation behind the purpose of dashboards and pedagogical design of the learning activities included in the dashboard in providing feedback to students. The research has also shown that student characteristics, such as goal orientation and motivation can have a considerable influence on how dashboards are interpreted by students. Designing dashboards to address these issues presents a particular challenge to educational technology vendors who often seek to provide a ‘one-size-fits-all’ dashboard product to institutions. The emerging research would indicate that this approach, as Teasley (2017, p. 6) suggests, ‘may be unwise’.

So, if we return to where we started, to the history of dashboards and their role in supporting decision-making in business and engineering, we see that the audience for this form of feedback are experts in their field. However, while students have experience at being students, they are not experts in education. They often lack sufficient knowledge about the pedagogical intent of learning activities, the design of assessment, and an understand of how this all fits within the broader curriculum. Additionally, they may not have adequate levels of data literacy to be able to understand the statistics and visualisations presented in dashboards and reports (MacNeill, Campbell, & Hawksey, 2014; Vezzu, VanWinkle, & Zapata-Rivera, 2012).

These challenges highlight the importance of the provision of support for the interpretation of feedback given through learning analytics dashboards. This can be done in a number of ways including the incorporation of visual elements and descriptions to accompany data representations, the provision of supporting materials, or the provision of face-to-face support from
Evaluating Students’ Interpretation of Feedback

Teachers and/or academic advisors. Tactics such as the use of evidence-based or stealth assessment designs could also help to strengthen students’ understanding of learning objectives and expectations of performance (Shute & Kim, 2014). Important lessons can also be learnt from the work on creating reports for ‘open learner models’ which looks at ways to provide information to students about the content and skills associated with educational systems such as intelligent tutoring systems (Bull & Kay, 2016; Bull, Wasson, Johnson, Petters, & Hansen, 2012). This work demonstrates how visualisations of data can be built within the context of a learning activity design and adapted for students in ways that allow them to explore different levels of granularity, effectively creating an ‘active report’ (Zapata-Rivera, Hansen, Shute, Underwood, & Bauer, 2007). The value in these approaches is that visualisations are grounded within a model that clearly represents the design of the learning activity, helping to support and raise students’ metacognitive awareness (Vatrapu, Teplovs, Fujita, & Bull, 2011).

In designing such support and evaluating the interpretations that students make of feedback delivered through dashboards the field of learning analytics would be wise to look to work already done in other disciplines. As has been outlined in this chapter, the field of score reporting provides useful information on ways that feedback can be visualised as well as models for the evaluation of student interpretations of this feedback. This literature and the emerging literature on evaluation of dashboards in the field of learning analytics suggests a move beyond simple measures of student satisfaction and usability towards methods which can capture students’ understanding of the feedback as well as the ways that they translate these understandings into action. The proposed stages of score report development models presented here (Zapata-Rivera & VanWinkle, 2010; Zenisky & Hambleton’s, 2012a) are also useful to ensure that evaluation is built in across the whole dashboard development process. There is lots of work still to be done in determining the most effective ways of designing student dashboards, but by drawing on these evaluation models as well as educational theories and learning designs, institutions and teachers will be better placed to design dashboards that provide useful feedback to support student learning.

References


