Abstract

Learning analytics has become a buzzword, in practice often accompanied by comprehensive use of digital technologies. This study takes a qualitative approach by analysing performance data within the bounds of one module. High failure rates prompted an action research study to check for performance patterns as seen at the exam. Generally, students were successful at conducting calculations, but struggling when being asked conceptual and theoretical questions. Further analysis demonstrated a lack of alignment between tasks posed in exercises and at the exam. Particularly in the second half of the course, students claimed they were asked theoretical and conceptual questions that had not been previously addressed in the exercises. The project set out to align conceptual and algorithmic tasks as featured in the various parts of the curriculum. Furthermore, a theoretical mid-term test was introduced to focus exclusively on conceptual issues, some of which were re-addressed at the final exam. Due to the interventions, failure rates were greatly reduced and with students’ feedback generally supportive.

Keywords: Learning analytics; task design; quality assurance; learning paradigm; teaching paradigm.

1 INTRODUCTION

Quality assurance procedures are now typically mandated at almost all higher education institutions, and ambitious claims are made about what such systems can achieve. Quality assurance programs have multiple aims; however, almost often with a particular focus on student satisfaction of teaching. Such programs are typically the responsibility of university managers and administrative staff, carried out throughout and by the end of each semester. The claims made for quality assurance programs rest on the assumption that satisfaction studies of teaching and other support structures serve as valid indicators of “quality” – a construct that is frequently used, but only rarely accompanied by a definition.

Historically, a distinction has been made between “quality assurance” and “quality enhancement”, but in a recent policy document [1] the former term is taken to describe all activities within the continuous improvement cycle (i.e. quality assurance and enhancement activities). In this paper, a distinction is maintained for clarity purposes. At the current university, “quality assurance” interventions are typically intentionally based with no requirements of evidence of effects. Students are typically treated as customers, data are collected and academics are assumed to adjust according to students’ likes and dislikes. When “quality enhancement” is targeted, evidence of effects is legitimate; however, the widely differing conceptualizations of the construct of “quality” make this a challenging task.

In a study of the concept of “quality”, five interrelated definitions were identified; quality as exception, as perfection, as fitness for purpose as value for money, and as transformative [2]. While the transformative dimension appears as particularly important, it is hard to measure. In this study, we are concerned with learning and achievement in a science and engineering module at bachelor’s level. The ambition was not to gauge individual advances, but rather to improve the overall performance of next year’s cohort based on insights gained in the previous year. Failure rates had remained high for several years without anyone being able to figure out why. The author’s interest in the project was motivated by a desire to better understand how entities were connected and related to each other.

The approach taken has come to be known as Learning Analytics (LA). This is a fairly recent research development that has expanded due to the increase of available data. As a consequence, researchers have been on the outlook for methods to better understand and make sense of such data. While more commercial sectors have invested heavily in analytics as a solution to their business interests, higher education has so far been lagging behind. However, recent years have seen an explosion of interest also in this sector, e.g. to increase retention and improve learner support [3]. The purpose of this study is not to trace the diverse roots of LA, nor to engage with sophisticated algorithms intended to analyse behaviours of large numbers of students. The purpose is rather to recognize the complexity of the learning environment, collect and analyse data to support future grounded action. While digital technologies may enable future system wide studies, this project adopted a bottom-up approach with
data collected manually only in the involved module. This represents a small-scale, principled and safe approach that can be used by professors, while waiting for more mature technologies to emerge in LA.

2 CONTEXT AND RATIONALE

Approximately 40 students were enrolled in the course, which was mathematically based and required foundational knowledge and skills in mathematics and statistics. The workload was estimated to 7.5 credits, or 25% of the total for the semester. Lectures were provided along with weekly exercises, and students were offered assistance in the tutorials. In preceding years, student evaluations of teaching had turned out positive with no indication of any serious issue. Paradoxically, failure rates fluctuated just around 30% annually. As a step to improve the situation, an action research study was initiated. Action research is a disciplined process of inquiry aimed to serve those taking the action. The reason for engaging in action research was to assist the actors in pursuing their own ideas for improvement. This methodology offers a step-by-step procedure that may be followed future cycles of inquiry.

Performance scores at the exam constituted the data source. Scores were assigned to each question in both parts of the module. The scoring scale ranged from 0-100 with 40 as the threshold pass level. Total scores were subsequently converted into letter grades ranging from A to F; however, numerical scores were used in this study for analytical purposes. Unfortunately, there are pitfalls associated with this approach, and achievement scores were therefore used as indicators of performance. Finally, on course completion a survey was administered to collect comments and ideas in relation to changes implemented in tasks, as seen in both sets of exercises, a new mid-term test and at the final exam.

3 ANALYSIS

The approach adopted in this study is known as learning analytics, defined as the collection, analysis and reporting of performance data for purposes of understanding and optimizing learning outcomes. Scores were used to identify patterns of strengths and weaknesses, which were subsequently used for theorizing explanations. The learning environment is seen as a complex system consisting of a range of components potentially impacting the ways in which students go about learning. Consequently, the term “teaching” in this study incorporates any activity aimed to improve learning [4].

While students exhibited acceptable algorithmic ability, conceptual understanding was largely missing. This had been observed for several consecutive years, especially in part two of the module. The professors theorized this might be ascribed to a mismatch between tasks in the exercises versus the exam, and that one measure would be to align types of tasks [5]. Rather than fine-tuning lecturing styles, time was invested in a re-design of both sets of exercises since this was considered the most direct way of getting students engaged in targeted learning experiences. More conceptual tasks were added to enhance conceptual understanding and reduce rote learning. Furthermore, a mid-term exam dealing solely with theoretical and conceptual content was introduced to promote targeted learning.

Shortly after the exam, students’ experiences and comments were collected by way of an electronic survey. Generally, the greater emphasis on theoretical and conceptual questions was well received; however, interesting ideas for future revisions were also suggested. They were largely related to the nature and scope of conceptual questions, and aspects of the relative weightings of the mid-term versus the exam. A selection of student responses aimed to enhance learning is cited below:

- I really enjoyed the course! My suggestion is that more conceptual questions are implemented in the exercises. In part 1 I felt like I spent too much time doing calculations in excel and in part 2 the calculations should have been shorter and perhaps a bit more difficult.
- Try to have physical or real life examples to connect the theory to something practical. The course is highly theoretical, and it has to be, but I think it will be good for the students to be given some real life examples in order to get a better understanding of the subject.
- I think more theoretical questions should have been included in the exercises and less calculations in excel. Time on the different concepts was well spent. I think some of the calculations were a bit too long to go through in class, but the level of the class was in general very suitable … I would have liked more time to understand the concept of frequency response function and impulse response function.
I think I learned very well. The first part could in my opinion have been covered faster, especially the basic statistics part. This would have given more time to statistical inference and transformation of variables, which from my point of view demand more work.

After all I thought the grade in the course should reflect the knowledge the student has when finished with the course - no employer would ever care how much ... you knew in the middle of the semester. To improve learning - make the midterm count positive 30% and hence the students making a great effort through the semester will be rewarded. ... I did a good exam, but the only think an employer will see is my C in the course due to my terrible midterm, because I had other priorities in the middle of the semester.

The first four bullet points all deal with the nature of tasks, e.g. the balance between conceptual and algorithmic questions, level of difficulty, workload and the use of principles versus examples. Other issues touched upon were learning for understanding versus memorization, and time devoted to topics within the curriculum. Some topics are conceived easier or more familiar than others, so consequently time spent on certain themes could have been redistributed to strengthen learning in other parts: “The exercises have been too difficult and time consuming … I would have preferred to have easier/more similar exercises to the exams, without a solution available” [NN]. It is of course impossible to meet all individual needs of students, but some are well reasoned and definitely deserve further consideration.

Due to the interventions, failure rates dropped significantly compared with previous semesters. This occurred while students had no previous mid-term questions to consult for preparation. However, the mid-term exam provided an example of conceptual tasks to be asked at the end-of-term exam. Within science and technology programs previous exams are often the best source of information on future exam questions, as illustrated by this respondent: “And for God’s sake give the poor student some material as old mid-terms or exams before the mid-term! Reading those poorly written compendiums to find your precious “conceptual issues” could give anyone the thoughts of suicide!” [NN].

4 DISCUSSION

The main argument of this study is the need to shift the balance of efforts from fine tuning of lectures to learning analytics and design of courses. This conclusion is well supported empirically; however, often missing in quality frameworks. Beliefs about teaching is often formed by custom rather than by critical reflection, and measures to ensure standards reflect common sense understandings of key terms, such as “teaching”, “learning” and “quality”. A common understanding of “teaching” is that of transmission of knowledge, and quality initiatives frequently (tacitly) assume this notion. However, if universities stick with this definition, they are likely to remain fixated on issues such as presentation style, speed and progression of lectures rather than questioning evidence of effects on learning.

The purpose of educational design is to provide learning environments that are conducive to targeted learning outcomes, and there is a growing awareness of the centrality of design to impact learning. This hinges on the notion that learning is closely related to what students do rather than what the teacher does [Biggs]. This implies a conception of teaching with responsibilities more associated with facilitation of learning processes rather than transmission of knowledge, even though in most cases those functions are combined. Providing appropriate tasks and questions is the most direct way to impact learning, and there is potentially much to gain by increased attention to this aspect of the learning environment. Design approaches to teaching are still rare, and task design in particular is in its infancy. Unfortunately, the literature offers no quick fix to complex and contextually related issues, but guidelines on constructive alignment are well known […] as are taxonomies on learning […]

Task design is a professional responsibility that cannot, and should not, be transferred to third parties. Central questions to be asked are what should be learned, why and how? Disciplinary knowledge and experience are essential preconditions; however, taxonomies are likely to raise levels of awareness and to broaden the spectrum of tasks, and combination of tasks, to suit purposes. Engaging students in reproductive processes is different from getting them engaged in higher cognitive skills, for example reflection, analysis and criticism. Manipulating sophisticated equations and formulae may impress and give the shine of expected learning at first sight, while control questions may reveal different realities. Solving numerical tasks does not necessarily imply understanding of associated conceptual issues.

In this study, learning analytics pre dates task design. Learning analytics involves an ability to identify and analyse trends in data in order to theorize what is going on. Theory generation assumes the ability to make sense of complex and chaotic environments. Theories are provisional and constitute steps towards deeper insights of how variables interact and impact on each other. They are not about “good”
or “poor” teaching, so evaluation instruments would not be used primarily for that purpose. Rather, the combination of an explanatory theory and an operational theory combines insights with an action plan. Design is important because tasks are major constituents of drivers in learning, as seen in assignments and exams. Motivation and effort are strengthened by whatever counts towards grades.

A further argument to support focus on task design is the issue of grade integrity. This term has been defined as “…the extent to which each grade awarded, either at the conclusion of a course or module of study, or for an extended response to an assessment task, is strictly commensurate with the quality, breadth and depth of a student’s performance” [8, p. 807]. To comply with requirements of grade integrity, task design also becomes a key challenge in order to gather evidence that allow for strong inferences to be drawn about student learning, possibly also helping to curb grade inflation.

Task design is a learner centred activity indicating a shift from a teaching paradigm to a learning paradigm [Barr]. While teaching for many years has been seen as the primary goal, task design builds on the idea that learning is targeted while all forms of teaching are means towards that aim. This mental shift may be among the hardest barriers to overcome in design based approaches to learning.

5 CONCLUSION

Learning analytics has become a buzzword in today's educational debate, and much enthusiasm is associated with this in tandem with the use of technologies in higher education. Digitalization opens up for large scale quantitative data analysis of learning and learners aimed to transforming data into new insights to benefit the academic community. This study does not draw on vast amounts of data, but rather makes use of performance scores analysed within the framework of a course design. The process was disciplinary based, and the use of digital technology was not essential in the analysis. Rather, the approach was principled and theoretical, and demonstrates how learning analytics can be conducted within the bounds of a single course. Under no circumstances will human cognition and reasoning be superfluous in educational development, not even in an era of "learning analytics".

When learning outcomes is at stake, this study offers an approach with assumed potential compared with practices associates with quality assurance systems. Learning analytics is not about “good” or “bad”, but rather how variables are tied together – what causes what, how and when? The process implies an ability to identify performance patterns, and being able to act on the learning environment in attempts to improve learning. This is a non-trivial task, but one that can be improved by experience. This requires an ability to let go of past conceptions, to stay open and let data speak for itself. Still, we cannot fully predict the future, which to some degree implies trial an error to hit the best measures.

REFERENCES