Replacing Exam with Self-Assessment: Reflection-Centred Learning Environment as a Tool to Promote Deep Learning

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Abstract

A new blended learning environment encompassing a wide variety of formative assessment was developed for a large undergraduate mathematics course to promote deep learning approach. In order to enhance reflection, the final exam was replaced by students' self-assessment. At the end of the course, a cluster analysis found four student clusters differing in their deep and surface learning approaches. Analysis of open feedback questions suggests that the contextual factor most commonly associated with deep learning approach was innovative assessment. Our findings lead us towards understanding how to foster deep learning approach in different kinds of learners.

Keywords

Learning Approaches, Deep Learning, Blended Learning Environments, Self-Assessment

Introduction

Student learning in higher education can be described by means of students' approaches to learning. These approaches are often divided to deep and surface learning approaches (Biggs, 2012). The adoption of these approaches is known to be connected with student characteristics but also with teaching methods and assessment (Baeten et al., 2010). In order to support deep approach to learning in a large mathematics course, we created a blended learning environment designed to offer a wide variety of feedback to the students and to promote reflection throughout the course. Based on our earlier findings on self-assessment in higher education (Tuohilampi, Rämö, Häsä, & Pekkarinen, 2017), we left out the course exam and replaced it with formative self-assessment. Moreover, the assessment methods were not separate components, but instead they were woven into the students' everyday activities in the course. This was achieved by innovative use of digital course components.

Background of the Study

In our study, we seek to understand learning environments as diverse and complex structures that have the potential to alter students' learning strategies through reflection. Below, we briefly introduce the theory of learning approaches and the previous attempts to promote deep learning within different learning environments. We connect this background with the theory of blended learning environments, since in our learning environment the adoption of deep learning approach is promoted using both physical and digital elements.

Approaches to Learning. Approaches to learning consist of the combination of motivation and learning strategies of the student – very often these approaches are divided into deep and surface approaches (Biggs, 1987; Biggs, 2012; Entwistle 1991). A deep approach refers to a true intention to understand the content to be learned (Diseth 2003). It is linked with the idea of intrinsic motivation, "interest in ideas", and is allied to deeper pedagogical approaches that foster personal understanding (Entwistle 2000; Diseth 2003). Surface learning approach, on the other hand, is linked with using the least amount of effort to reach the minimal required outcomes (Biggs 1987; Garrison & Cleveland-Innes 2005). It can be said that the focus for surface approach learners is the completion of the task, not the growth with learning.

Deep learning approach has been valued more in the context of higher education (Garrison & Cleveland-Innes 2005). Sadler-Smith (1997) found a significant positive correlation between performance and deep learning in the context of higher education. Diseth (2003) observed the same connection; furthermore, he found that surface approach correlated negatively with performance in his study. However, deep and surface learning approaches are not to be seen as fundamental traits of students, as students have been observed to change their learning strategies with situational demands (Marton & Säljö 1976).

Creating Learning Environments that Support Deep Learning Approach. A large number of studies have investigated attempts to cultivate the deep learning approach within student-centred learning environments in higher education. However, the results of those studies are not consistent (Baeten et al. 2010). In their meta-analysis, Baeten and colleagues determined the factors needed to encourage deep learning approach; these were 1) contextual factors (teaching, assessment), 2) perceived contextual factors (how students perceive teaching and assessment) and 3) student factors (such as age and gender). The most successful strategies were determined within each of these factors. Those were found to be 1) innovative assessment and student-centred teaching, 2) satisfaction with the overall quality of the course and 3) intrinsic motivation. All these factors (contextual, perceptual and personal) need to be considered when designing a deep learning focused learning environment.

Innovative assessment methods prove to have a significant role in enhancing the adoption of deep learning approach within a learning environment. In their meta-analysis, Sluijsmans and colleagues found that self- and peer-assessment discouraged passive learning that was connected with surface approach (Sluijsmans et al., 1998); however, the use of these assessment methods was observed to require a lot of training. Increasing the variety of assessment in an active learning environment can increase the students' feeling of responsibility for their own learning and therefore enhance deep learning approach (Wilson & Fowler 2005). However, innovative assessment methods can also lead to adoption of more surface approaches when the terms of assessment do not require deep learning approaches (Gijbels & Dochy, 2006; Struyven et al., 2006). Learning environments can especially foster the adoption of deep learning approach if they encourage students to reflect on their own learning (Sobral, 2001; Waters & Johnston, 2004).

The research on the processes of deep learning within learning environments has focused on finding patterns inside the whole sample, which has been considered to be a weakness (Wilson & Fowler 2005; Baeten et al. 2010). In this study, we try to identify those subgroups of the student sample that are not able to benefit of the various feedback forms that we offer to foster reflection through our blended learning environment.

Blended Learning Environments. At its simplest, blended learning refers to providing digital learning materials in a physical classroom environment (Garrison & Kanuka 2004, 96–97; Singh 2003, 52–53). In this study we use a more complicated model to capture the diversity of support mechanisms of the reflection-centred learning environment. According to Manninen and colleagues (2007), blended learning environments can be seen to be composed of five dimensions that are separate yet overlapping: 1) physical environment (the space and buildings around learning situation), 2) social environment (the social interaction of learning situation), 3) digital environment (learning technology, ICT), 4) local environment (learning in the "real world", learning where the skills are needed), 5) didactic environment (learning as a centre for the learning environment). The learning environment that we developed reflects all the introduces elements (Figure 1).

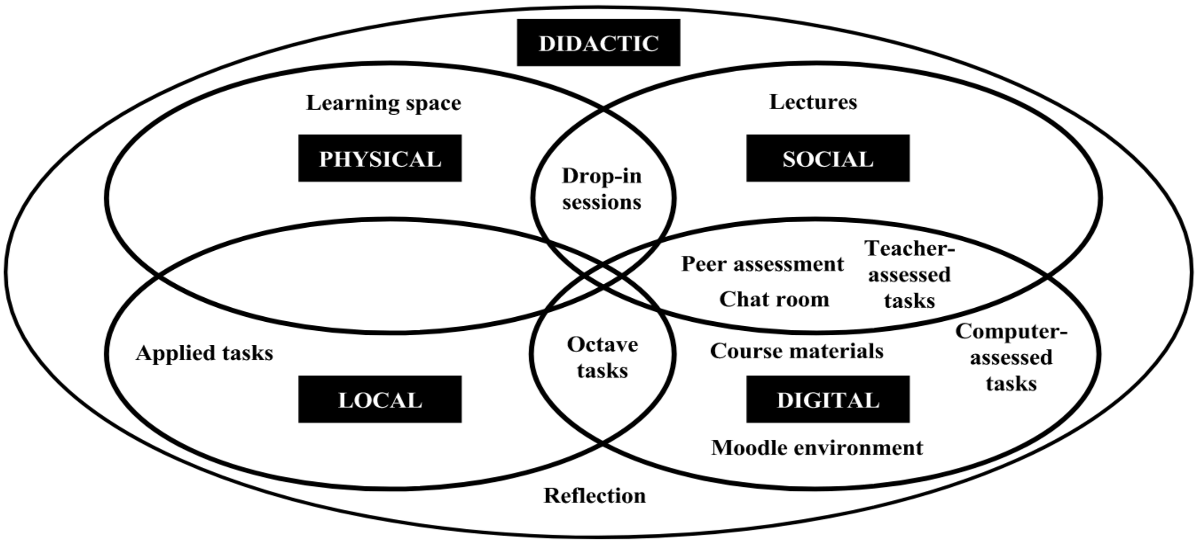
In our study, we seek to examine the connections between our learning environment and adoption of deep learning approach. However, unlike many course settings described in the literature (Baeten et al., 2010), ours is based exclusively on reflection. In our course, the whole culture of assessment is flipped, as we replace the traditional course exam with a variety of formative, digital assessment methods, such as self-assessment, that require a high amount of reflection. This led us to call our setting a "reflective-centred, blended learning environment". In the next section, we provide more details about the course setting.

The Pilot Course with a Blended Reflective-centred Learning Environment

The blended, reflective-centred learning environment investigated in this study was created for the course Linear algebra and matrices I. The course was taught in the Open University of the University of Helsinki during six weeks in May–June 2017. The course had 164 students, most of whom were degree students from the University of Helsinki, majoring in mathematics or a related discipline. Teaching in the learning environment was based on the Extreme Apprenticeship Model (Vihavainen, Paksula, & Luukkainen, 2011; Rämö, Oinonen and Vihavainen, 2016). It is a teaching model in which students take part in activities resembling those of experts. A central feature in the model is formative assessment.

All the digital features of the course were implemented in the digital learning platform Moodle. All course materials, such as lecture notes and problem sets were offered electronically, and all submissions were also handled electronically. Figure 1 shows the components of the learning environment divided into the five different dimensions indicated by Manninen and colleagues (2007).

Figure 1
The reflection-centred learning environment divided into dimensions (Manninen et al. 2007).



Each week, students were given a set of problems to solve. Some of the problems were digital tasks created with a system for automatic assessment called Stack (Sangwin 2013). For these tasks, instant automatic feedback was offered. Others were manual tasks completed with pen and paper and then scanned for submission. For a subset of the manual coursework, the students received written comments from the teachers or peers. The problems included real life applications of the topics discussed. Some tasks involved the use of a typical mathematics software Octave. For solving the problems, students were offered guidance in drop-in sessions that took place in a specially designed learning space. The students could also ask for help anonymously in an online chat room.

There was no final exam. Instead, grades were determined by formal self-assessment.

Students based their self-assessment on a learning objectives matrix which contained the objectives of the course, concerning both mathematical content and transferable skills. The latter included skills such as reading mathematical text and giving and receiving feedback. The students assessed their mastering of each topic and awarded themselves a grade for the course, with written reflection justifying their choice. The self-assessment was compared automatically to the coursework completed by the student, and if the two agreed, the grade given by the student to her/himself was confirmed. In case of discrepancies, the student was asked to justify their opinion or suggest themselves another grade.

Goals of the Study

The aim of this study is to analyse the blended reflection-centred learning environment described above from two perspectives: 1) What were the levels of deep and surface learning experienced by the students, and what kind of subgroups of students were there in terms of their learning approaches? 2) Which contextual factors (Baeten et al. 2010) did the students connect with deep and surface learning approaches? These questions need to be asked in order to develop the reflective-centred learning environment in the direction that would foster deep learning approach. We need to find the student groups that require help in developing their learning strategies, and separately, we need to know which components of the course are best suited to promoting deep approach.

Data Collection and Analysis

Learning approaches were tested with a ETLQ-questionnaire validated in Finland (Parpala, Lindblom-Ylänne, Komulainen, & Entwistle, 2013). The deep approach and surface approach subscales both consisted of four items ($\alpha = .62$ and $\alpha = .75$, respectively). The statistical measurements were conducted with IBM SPSS Version 24.

The qualitative data concerning the second goal of the study was collected after the pilot course with the same questionnaire as the learning approaches. The descriptive, one-shot questionnaire was designed with the guidelines of Lodico and colleagues (2010, p. 159–171). The questions were used both in research and in the development of the course, and the questions concerned, for example, the experiences about self-assessment ("*How did you experience the fact that there was no exam in this course?*") and support ("*How have you been able to benefit from the feedback during the course?*"). The questions about supportive elements in the reflective-centred learning environment were based on the interview questions by Mumm and colleagues (2015). The data was collected in Moodle.

The qualitative analysis was based on content analysis by Miles and Huberman (1994). The pool of all the open answers of the course feedback was used as a source for data. First, the content analysis was started as conventional (Hsieh & Shannon, 2005). We searched the data for all the expressions of deep and surface approach; this step was influenced by the previous knowledge about the theory of those approaches. Since the length of the answers varied, the analysis unit was chosen to be a coherent idea present in the text (Schreier, 2012, p. 131–134). There were 74 units where the students described their learning approach as deep or surface; these units were then reduced, deep and surface approaches separately. This way we looked for the contextual factors of the learning environment that influenced the learning approaches. The reduced expressions were grouped into categories, which were then grouped again as category classes and subclasses. Finally, the found category classes were connected with the theory of the elements of a blended learning environment (Manninen et al., 2007).

Findings

Levels of deep and surface approach. Overall, deep learning approach (M = 3.89, SD = .66) was reported to be higher than surface learning approach (M = 2.07, SD = .70) after the course. A cluster analysis was conducted to determine whether there were any subgroups of students in terms of learning approaches. Deep and surface approach factors were considered to be the cluster variables, since that choice is aligned with the research question and the chosen variables encode the maximum amount of information about the students' learning approaches (Theodoridis & Koutroumbas 2006). Since there was no preconceived idea about the correct number of clusters, a hierarchical cluster merging was used for exploratory design (Antonenko et al. 2012). Ward's algorithm (Ward 1963) was chosen for clustering algorithm to decrease the differences among the clusters. The scores of the variables were standardized to Z-points before the analysis.

The data was first analyzed in the form of a dendrogram. Observing large gaps between the cluster sets (Olson & Biolsi 1991) identified three or four separate clusters. The number of clusters was ensured by performing a discriminant function analysis on the data (Romensburg 1984). The solution with three clusters predicted cluster membership by 92 %, whereas the solution with four clusters predicted that by 95,5 %. Since the four-cluster solution divided the students who reported a lot of surface approach into their own yet small group, it was selected as the most appropriate one for this study. The differences of the means of the main variables between the clusters are shown in Table 1.

Table 1

Deep and surface approach, task points and course grades of the four clusters.

		Surface approach	Deep approach	Tasks with automatic feedback (max. 64)	Tasks with no feedback (max. 40)	Tasks with teacher feedback (max. 9)	Grade (scale 1–5)
Total	M	2.07	3.89	52.71	31.94	7.93	4.10
n = 113	SD	.70	.66	10.45	8.76	1.70	1.45
Cluster 1	M	1.90	3.14	51.16	30.10	7.57	3.75
n = 30	SD	.41	.51	10.68	8.19	1.96	1.74
Cluster 2	M	1.45	4.38	56.17	35.86	8.25	4.58
n = 36	SD	.28	.41	7.65	7.34	1.76	1.20
Cluster 3	M	2.40	4.06	51.76	30.92	7.94	3.97
n = 36	SD	.28	.41	10.75	8.56	1.57	1.45
Cluster 4	M	3.60	3.73	48.30	27.00	7.80	3.63
n = 10	SD	.39	.48	14.92	11.45	1.03	.92

The four clusters were compared using ANOVA. The assumption regarding the homogeneity of variance was met for all the other variables (Levene test, p = .06– .73). The clusters 1 (n = 30), 2 (n = 36) and 3 (n = 36) are considered to be normally distributed by their variables. Cluster 4 (n = 10) was tested; all the variables were normally distributed (Kolmogorov–Smirnov test, p = .61–.20). ANOVA was then used to identify differences between the clusters regarding the variables shown in Table 1.

Unsurprisingly, significant differences were found regarding surface approach (df = 3, F = 128.9, $p < 0.001$) and deep approach (df = 3, F = 45.19, $p < 0.001$). Apart from these differences the only significant difference between the groups was found regarding the points from non-assessed tasks (df = 3, F = 312.27, $p < 0.05$). Small yet insignificant differences were found between points from automatically assessed tasks (df = 3, F = 243.68, p = .081) and course grades (df = 3, F = 4.73, p = .078).

Finally, Bonferroni Correction Post Hoc Test was conducted to find out the exact clusters that had the most significant differences between them. All the clusters differed significantly in terms of surface and deep approach ($p < 0.05$) except clusters 3 and 4 that only differed in terms of surface learning. The students in clusters 1 and 4 were shown to have completed significantly less non-assessed exercises than the students in cluster 2 ($p < 0.05$). No other differences were found.

Contextual factors connected with learning approaches. The contextual factors connected with deep and surface learning approaches were investigated with a qualitative content analysis of the open answers of the students. The categories of contextual factors that promoted deep learning approach are shown in Table 2. The number of expressions found in each category is reported in brackets.

It was found that innovative assessment was the main contextual factor to enhance deep learning in the reflection-centred learning environment. Students also reported that student-centred course materials supported deep learning since they provided information about the exact learning goals and the relations between them. Interestingly, all the expressions found were connected with the digital learning environment, as seen in Table 2.

Table 2
The contextual factors (Baeten et al., 2010) reported to promote deep learning approach.

<table>
<tr><th>Categories</th><th>Category subclasses</th><th>Category classes</th><th>The dimension of the learning environment (Manninen et al.2007)</th></tr>
<tr><td>No exam (22)</td><td rowspan="2">Replacing exam with self-assessment</td><td rowspan="7">Innovative assessment</td><td rowspan="2">Digital & didactic</td></tr>
<tr><td>Self-assessment tasks (13)</td></tr>
<tr><td>Variety of feedback (4)</td><td rowspan="5">Various forms of feedback</td><td rowspan="2">Digital, social & physical</td></tr>
<tr><td>Formative feedback (3)</td></tr>
<tr><td>Feedback from peers (4)</td><td rowspan="2">Digital & social</td></tr>
<tr><td>Teacher-assessed tasks (1)</td></tr>
<tr><td>Automatic feedback (2)</td><td rowspan="3">Digital</td></tr>
<tr><td>Learning objectives matrix (6)</td><td rowspan="2">Course materials</td><td rowspan="2">Student-centred course materials</td></tr>
<tr><td>Lecture notes (1)</td></tr>
</table>

Students linked deep learning strategies directly with the learning environment in their open answers, but that was not the case with surface learning approach. Instead, surface approach was, for example, connected with traditional exams; students described that in other courses they might attempt to memorise the lecture notes a couple of days before the exam. Also, some students linked the non-assessed tasks with surface learning by mentioning that they completed them with lesser effort than the rest of the tasks, the reason being that the non-assessed tasks were unmotivating since no feedback was provided.

Discussion

In our study, we found that the reflective-centred, blended learning environment, based on various formative assessment methods such as self-assessment, was a promising course experiment in terms of promoting deep learning approach. Quantitative and qualitative analyses were conducted to explore the levels of learning approaches within the student population and to find the course components that were connected with the processes of deep and surface learning.

Four student clusters differed from each other in terms of deep and surface learning approaches. Two of those student groups might be considered to be "at risk" as they reported either a high level of surface or a low level of deep approach. According to Wilson and Fowler (2005), there is a need to foster "deep shift" within the students that are typically surface-oriented learners. Our cluster analysis found only 10 students reporting high levels of surface approach, which might mean that our learning environment was able to foster deep learning even among those students that would typically be surface-oriented.

A qualitative content analysis showed that the students formed fewer connections between surface learning strategies and the course components than between deep learning and course components. This, together with the fact that the size of the cluster of students reporting high surface approach was small, indicates that in the future there might be a bigger pressure to promote deep learning approach than to prevent surface learning approaches in this kind of course context. These arguments should, however, be tested in a similar setting with pre-tests and deeper qualitative data.

The course grades did not differ significantly between the different clusters. We argue that this is because of the carefully built support system that allowed the students with less productive learning approaches to complete a large number of tasks, which then enabled them to assign themselves high grades. However, it was found that the students in "at risk" clusters completed less non-assessed tasks than their peers. Non-assessed tasks were also one of the only contextual factors that were linked with surface approach in the course feedback data. It might be that the lack of feedback for these tasks discouraged the students with less deep learning strategies from trying them, as these students were not prepared to reflect on their progress when there was no formal external assessment and no deep learning was therefore required. A similar effect has been observed in previous research, namely that there is a connection between tasks that do not require deep learning and the emergence of surface approach (Gijbels & Dochy, 2006; Struyven et al., 2006). In the future, there is a need to explore which elements of our non-assessed tasks promote surface approach.

In students' open answers, the reflection-centred learning environment was largely connected with expressions related to deep approach especially in terms of innovative assessment methods, which is in line with previous research (Baeten et al. 2010). Interestingly, all course components that students connected with deep learning approach were part of a digital learning environment (Manninen et al. 2007). Based on this finding and the large amount of deep learning approach reported by the students, we suggest that blended learning environments are viable surroundings for promoting deep approach. This finding has value especially in the context of large-enrolment courses, where digital tools can be used to alleviate the demand for resources needed to foster student-centred teaching.
There is a need to develop the digital self-assessment component of the course since it was connected with deep learning in our data. Studying the "at risk" clusters might help us in understanding how to engage different kinds of learners to reflect on their learning, and furthermore, to take responsibility of their own learning processes.

Limitations of the Study. The open questionnaire answers did not allow us to analyse further nor validate the four clusters of students in terms of learning approaches. Also, we focused on the contextual factors of the learning environment; a substantial analysis of the perceived contextual factors would shed more light on the roles of the different course components in supporting deep learning. In order to address these issues, broader qualitative data will be collected in the next implementation of the course, especially in the form of student interviews.

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