FLIPPED CLASSROOM ASSESSMENT: A LEARNING PROCESS APPROACH

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ABSTRACT

A successful flipped classroom relies heavily on student engagement in pre-class learning and their active participation in classroom activities. However, much to students' disappointment, their efforts in the learning process often go unnoticed in traditional assessment approaches (such as term papers and final examinations) that are more product-oriented. As one of the important goals of the flipped classroom approach is to improve students' learning behaviors and attitudes, we argue that more attention should be shifted to assessing the learning process in order to align with such goal. In this paper, we advocate the use of learning analytics as one of the assessment components in flipped classrooms. We show how this change in assessment can be beneficial to both student learning and teacher reflection. We also indicate some limitations on current learning management systems (LMS) in providing the learning analytics for assessment purposes and suggest several revisions on LMS for better facilitating implementation of the flipped classroom approach.

KEYWORDS

Flipped Classroom, Assessment, Learning Process, Learning Analytics

1. INTRODUCTION

A typical flipped classroom model moves lectures out of the classroom (usually in the form of multimedia) and allocates more class time for students to actively engage in higher-order tasks such as problem-solving and debates (Bergmann et al., 2012). The pedagogy is believed to be able to meet the recent higher education standards which place emphasis on the value of student-centered learning environments and active learning strategies. The learning activities introduced into the flipped classroom not only invite students' engagement and thinking but also provide opportunities for students to construct their own knowledge by exploring learning materials themselves. These agree with the active learning principle (Gannod et al., 2008). Moreover, these learning activities are often designed according to students' ability, learning style, and learning pace. In this student-centered learning environment, teachers can have more interaction with students, and it would be easier for teachers to discover and pay attention to weaker students.

Previous studies show that students achieve better learning outcomes in the flipped classroom. In the research of Davies et al. (2013) and Mason et al. (2013), statistical evidence shows that students in a flipped classroom perform better and show greater satisfaction than their traditional classroom counterparts. Three factors may contribute to the enhancement of students' performance. First, the flipped classroom allows teachers to use class time more effectively, so they can cover more topics (Bhagat et al., 2016; Gannod et al., 2008). Second, engaging learning activities in the flipped classroom motivate students to learn. Third, the performance of low achievers improves because the learning environment allows teachers to pay more attention to them (Bhagat et al., 2016).

The advantages of the flipped classroom pedagogy are not limited to improving students' achievement on the learning outcomes. In a flipped classroom, learning materials are distributed in the form of multimedia outside the classroom, so students can access anytime whenever they need (Gannod et al., 2008). On the one hand, it provides the flexibility for students to work at their own pace (Fautch, 2015). On the other hand, it cultivates their responsibility for and self-regulation in learning (Baker, 2000). The learning activities that introduced into the classroom also increase students' engagement (Khanova et al., 2015). In short, it can be said that the benefits of the flipped classroom approach also encompass students' learning process.

Besides the learning outcomes and the learning process, assessment is also an important component in an instructional process. In such a process, "learning outcomes" describes the desired result. These outcomes include disciplinary knowledge and skills. "Learning process" contains activities that are the means to help students attain these outcomes. "Assessment" provides information that helps teachers decide how well students are progressing or attaining the outcomes (Russell and Airasian, 2014). The three components must be closely connected for a successful instructional process. The learning outcomes guide the planning of the learning process so that the learning process can assist students to attain the learning outcomes. The learning outcomes define the standard and criteria for the assessment so that the assessment allows students to demonstrate how well they have attained the learning outcomes. The learning process hence becomes a preparation for the assessment. On the other hand, the assessment also assesses the effectiveness of the learning process (Russell and Airasian, 2014). This relationship can be conceptualized as figure 1. It is believed that students' achievement in the learning outcomes is derived from the learning process, so the effectiveness of the learning process can be assessed solely by assessing students' achievement in the learning outcomes. However, some researchers point out that alignment of test content to learning outcomes are not enough; test content should also align with the learning process in order to enhance students' motivation, attitude and classroom climate (Bonner, 2013; Nitko, 1989). In the past, however, without ways to assess the learning process, it was difficult to align the assessment with the learning process.

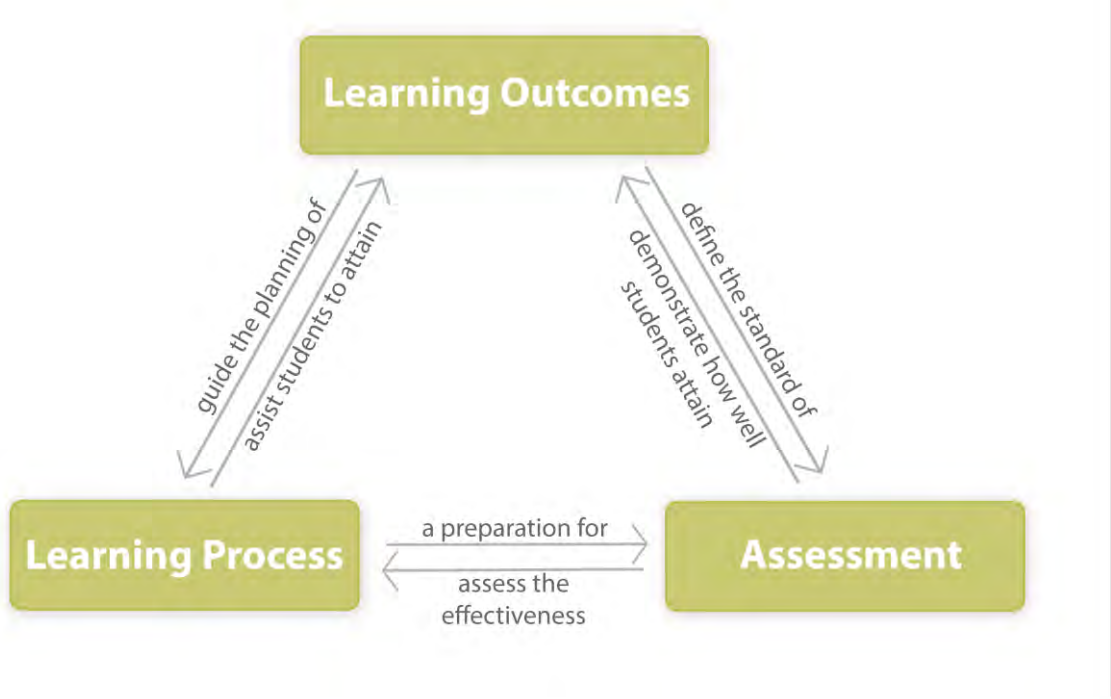

Figure 1. A successful instructional process

This article demonstrates how assessment approaches in the traditional, non-flipped class fail to align with the flipped classroom pedagogy and advocates an assessment that focuses on the learning process. The next part of this article explores this misalignment in detail. The third part of this article introduces an assessment that focuses on students' learning process through the use of learning analytics. In addition to assessing students' learning process, this assessment can also provide feedback for students' improvement and offer data for teachers' reflection. Because this assessment approach is highly dependent on learning analytics, some improvement to the existing LMS and some functions that can enhance this assessment are suggested.

2. THE PROBLEMS OF TRADITIONAL ASSESSMENT IN FLIPPED CLASSROOMS

2.1 Assessment Approaches in a Traditional Classroom: Outcome Assessment

In implementing the flipped classroom, retaining assessment approaches in a traditional, non-flipped classroom will have a potential danger of misalignment. Previous research warns that these "traditional assessment approaches" might not be able to adequately assess the benefits of the flipped classroom, especially those on students' skills, learning attitudes and behaviors, which can only be observed through the learning process (O'Flaherty and Phillips, 2015; Gillette et al., 2018; Persky and McLaughlin, 2017; Chen et al., 2018; White et al., 2017). The "traditional assessment approaches" that previous researchers mentioned includes pen and paper examinations (Persky and McLaughlin, 2017), assessment that focuses on students' performance, including examinations on theoretical knowledge and practice (Cheng et al., 2017; White et al., 2017), essay writing (Cheng et al., 2017), and projects (Persky and McLaughlin, 2017). These approaches can be summarized as the "outcome assessment" (Chen et al., 2018). Other forms of outcome assessment include the form of a quiz, end-of-chapter test, midterm or final examination, completing homework or worksheet, producing essay or term paper, or finishing project (Russell and Airasian, 2014). These outcome assessment approaches fail to align with the flipped classroom because they cannot assess the learning process of the flipped classroom.

The aim of the outcome assessment is to summarize students' achievement in terms of the learning outcomes (Russell and Airasian, 2014). Therefore, these assessment approaches only assess students' final achievement in order to assign grades to them. To summarize, the outcome assessment has the following weaknesses, making it ineffective in assessing students' learning process.

2.1.1 Product-oriented

In practice, the outcome assessment often requires students to produce tangible outcomes or products to demonstrate what they have learned in the whole instructional process. These products include not only projects, essays, and performances, but also includes tests and exams. Teachers will only assess students' products to judge whether students have achieved the desired outcomes or not (Russell and Airasian, 2014). Students know that only their attainment of the learning outcomes as demonstrated in their final products will be subjected to assessment. Their participation in the learning process is not being considered, hence they lack the incentive to participate in the learning process, and the benefits of participation in the learning process cannot be assessed.

2.1.2 Lack of Frequency

For the sake of efficiency, the outcome assessment often only takes place at the end of the learning process (Russell and Airasian, 2014). It is because the focus of the assessment is on the result of the learning process instead of the process itself, and the criteria of the assessment are the attainment of the desired outcomes at the end of the learning process. The outcome assessment thus becomes only a mechanism to indicate students' success. However, assessment in the flipped classroom should also serve as a mechanism to provide feedback about student learning (Persky and McLaughlin, 2017). This feedback can both evaluate and enhance students' learning process (Nitko, 1989). Frequent assessment of students' learning process thus can monitor and enhance students' learning process. Therefore, outcome assessment that only takes place at the end of the learning process fails to assess the learning process, and thus fails to align with the flipped classroom.

2.2 The Flipped Classroom Approach: An Emphasis on the Learning Process

In essence, the flipped classroom requires students to gain first exposure to the learning material before class. Different kinds of activities that promote deeper learning are introduced into the class, and students are required to participate in these activities with the help of the teachers (Brame, 2013). Therefore, preparation for class and participation in class are keys to the flipped classroom. The flipped classroom approach also requires students to be self-disciplined, responsible learners and to engage in the learning process.

Because students' active participation in the learning process is essential in the flipped classroom, students' limited preparation before class becomes one of the frequent challenges in the pedagogy (Akçayır and Akçayır, 2018). Both preparation and participation in the flipped classroom require students to pay more effort than conventional lecture-based classes (Al-Zahrani, 2015). Students sometimes do not prepare for their class, especially when there are no proper ways to check their preparation (Fautch, 2015). Regarding this challenge, Brame (2013) suggests that assessment tasks can be set to assess students' preparation, and the completion of these tasks can serve as evidence of students' preparation and part of the motivation for students to prepare for the class. In short, in the flipped classroom, assessment should also monitor students' learning process.

In conclusion, assessment approaches in traditional classroom focus only on students' learning outcomes, thus ignoring students' learning process. On the contrary, the assessment in the flipped classroom approach should assess students' learning process in terms of their participation and preparation in addition to their learning outcome. Traditional assessment approaches cannot fulfill the requirement of flipped classroom assessment, so it fails to align with the flipped classroom. Previous researchers propose some measures of assessment that focus on the learning process for the flipped classroom. In holding students accountable for pre-class learning, Persky and McLaughlin (2017) believe that frequent low-stakes assessment instead of high-stakes summative assessment at the end of the term would be more efficient. O'Flaherty and Philips (2015) also call our attention to the need for assessing students' engagement in flipped classes in addition to examination scores. The benefits of the flipped classroom can be better measured by an assessment that focuses on the learning process (Chen et al., 2018).

3. ASSESSING THE LEARNING PROCESS WITH THE LEARNING ANALYTICS

With the advancement in technology, students' learning process can now be observed and evaluated more accurately. This part introduces the use of learning analytics in assessing students' learning process. Through mining and analyzing the LMS data, students' participation in class and engagement with the learning materials outside the classroom can be assessed.

3.1 Learning Analytics: The Key to Assessing the Learning Process

Previously, observation of students' learning process has limitations in terms of the scope and the authenticity of the data. Teachers can only observe activities in the classroom, and such observation is subjective (Russell and Airasian, 2014). Students' engagement with learning material out of class is highly dependent on their self-report, which is limited due to issues on sampling and the size of data (Greller and Draschler, 2012).

The advancement in technology and the widespread use of the learning management system (LMS) provides us a way to directly observe students' learning process. The LMS can automatically track behind the screen all online activities of students when they access the system. It captures all digital footprints by all users, so it contains all data relating to students' learning process. Every click, every post, every social interaction, and every view-count of every page are recorded in the LMS. This corpus of learner-produced data can provide us valuable insight into students' learning process. The measurement, collection, analysis, and reporting of this data are termed "learning analytics" (Long and Siemens, 2011).

Researchers have already employed learning analytics to observe students' learning process. Their attempts prove that it is a reliable source for observation and can provide feedbacks to students, predict students' performance, detect students' behavior, group students, and analyze students' social network. (Romero and Ventura, 2010). By detecting students' behavior and analyzing students' social network, students' learning process can be assessed.

Since 2011, all the major LMS has included at least rudimentary analytics "dashboards" (Shum and Ferguson, 2012), providing some basic statistics of learning analytics. However, even for Moodle, one of the widely used LMS, reports of data and the function of data visualization are limited. Currently, plugins are required in Moodle to generate specific reports on the learning analytics and visualize them (Gaftandzhieva et al., 2018; Triantafyllou et al., 2018) and some researchers would transfer the LMS data to other statistic software for detailed analysis instead of using the LMS statistic module (Ravat and Dwivedi, 2019; Cantabella et al., 2019). In order to use learning analytics for assessment, some improvement of the current LMS is needed. These will be discussed in the discussion and conclusion.

3.2 An Assessment that makes use of the Learning Analytics

The learning analytics can provide various kinds of data for assessing students' learning behavior. For example, students' completion rate of different tasks and their behaviors in asynchronous discussion forums can be good indicators of their learning engagement and participation. In addition to assessing students, this assessment can provide feedback to teachers and students whenever they need because the learning analytics can be accessed anytime during the semester. Therefore, this assessment can serve three functions: it can assess students' learning process in the flipped classroom, it can provide feedback to students for their improvement, and it can offer data for teachers' reflection.

3.2.1 Assessing Students' Learning Process

The LMS contains data on students' access and completion of different tasks. Digital footprints would be left in the LMS when students access the LMS, download any learning materials, or finish any required tasks. Moreover, students' participation in the discussion forum can be revealed by mining the learning analytics. These data can show their engagement in the course.

Students' completion rate on tasks and assignments can be assessed on the LMS. Teachers can require their students to submit assignments on the LMS, and the LMS can show whether students' submission is on-time, late or not received. Moreover, learning analytics contains the data on students' number of downloads of learning materials (Cantabella et al., 2019), their number of different pages browsed, and total time for their browsing (Henrie et al., 2018). These sets of data can demonstrate how much time students spend on their learning. By visualizing these sets of data into simple statistic graphs, teachers can have a clear picture of their students' participation in the learning process.

Students' activity on asynchronous discussion forums may reflect their engagement level (Macfadyen and Dawson, 2010; Slattery, 2018). It is believed that engaging students tend to have more participation in discussion and have communicative connections with more peers. On the contrary, students with low engagement have communicative connections to a relatively small number of peers (Macfadyen and Dawson, 2010). Students' engagement can be measured by the number of posts, the number of replies, and the total number of words they posted (Slattery, 2018), and then, a network analysis on students' engagement in terms of how many other students they connected can serve as supplementary information.

Students' completion rate of tasks, access rate of materials, and their activity on discussion forums can help teacher evaluate their participation in a course, thus these sets of data can serve as an assessment. However, in some cases, "simply spending more time or having more activity on an assignment does not necessarily mean positive student engagement (Henrie et al., 2018: 359)", especially when students know that their learning process will be assessed. Students can pretend to be a self-regulated learner and engage in discussion forums without really paying attention to the learning content. Due to this limitation, it is not recommended that teachers assigning grades to students directly based on this assessment, although this assessment can still serve as a reference for teachers. On the other hand, teachers can use the result of this assessment to provide feedback for students' improvement in their learning process.

3.2.2 Providing Feedback for Students' Improvement

With accurate data on students' participation and engagement in their learning process, teachers can provide feedback regarding students' learning process. Since this assessment is carried out during the instruction period instead of assessing students at the end of the semester, teachers can provide feedback anytime in the whole semester. Students can use the feedback teachers provided to improve their learning behaviors and attitudes. It can be said that this assessment is a formative assessment (Russell and Airasian, 2014).

Assessment on the learning process is a continuous process. The LMS keeps tracking students' digital footprints. Teachers can access the learning analytics anytime to assess their students and provide feedback to students anytime they needed. Previous studies already show that teachers, with the help of learning analytics, can identify "slowing-down" students and provide assistance for them to catch up with the rest (Rosmanyah et al., 2017). Teachers can easily discover students with a very low number of accesses, assignments, and completion of quizzes by a simple statistic (Romero et al., 2008). Timely assistance can be provided to these students.

An early warning system that can identify at-risk students basing on learning analytics is demonstrated in Macfadyen and Dawson (2010). Their system used the number of forums posting, mail message sent, and assessment completed as variables. Students with low numbers in these variables were identified as disengaged students. The system would then automatically flag these at-risk students and remind the teacher to provide early intervention (Macfadyen and Dawson, 2010).

The flipped classroom can employ a similar system together with the assessment advocated above. The assessment on the learning process can evaluate students' access rate of the learning materials, completion rate of tasks and assignment, and their engagement rate by posts on discussion forums. These sets of data can be used as the variables for an early warning system. The system can highlight at-risk students and send warning messages to them. It can also remind teachers to assist them. These measures can prevent students from dropping out and motivate their engagement in the learning process.

3.2.3 Offering Data for Teachers' Reflection

The assessment can also offer data for teachers' reflection. Students' participation rate, completion of tasks and access rate of each of and all the learning materials can help teachers reflect upon their course design and teaching style (Greller and Drachsler, 2012), so they can improve their instructional design and manage classroom activities (Persky and McLaughlin, 2017). Students' access rate, participation rate and feedback, including the duration of students viewing and the view-count of each piece of material, can indicate which part of their course receives less student attention, and which part of their course is viewed by most students. Teachers can examine whether the form and style of delivery are ineffective in leading to student participation. In addition, by co-relating the access rate of each piece of learning materials to students' examination performance, teachers can also observe whether students' use of any particular learning material(s) have any positive or negative impact on their grade (Romero and Ventura, 2010). Thus, teachers can evaluate the effectiveness of their teaching through this assessment.

4. DISCUSSION AND CONCLUSION: A CUSTOMIZED LEARNING MANAGEMENT SYSTEM FOR FLIPPED CLASSROOMS

The flipped classroom pedagogy improves both the learning outcomes and the learning process, but assessment approaches in a traditional, non-flipped classroom usually focus only on the learning outcomes and fail to assess the learning process. In order to align with the flipped classroom, this article advocates an assessment that focuses on the learning process of the flipped classroom. This assessment assesses students by mining the dataset provided by the LMS. The data mining process, the "learning analytics", can demonstrate students' online learning process in a comprehensive way, thus making the assessment of the learning process possible. Such an assessment can assess students' participation and engagement in class. In addition, this assessment can also improve students' performance by identifying at-risk students during the semester, so that teachers can provide adequate help to them. Furthermore, it can provide data for teachers' reflection.

Because such an assessment is highly dependent on an LMS, the data provided must be accurate to ensure the fairness of the assessment. Previous research identifies some issues on the accuracy of the learning analytics. First, inaccurate data are recorded because of different technical issues. For example, the data on the duration of viewing may be inaccurate if the LMS allows students to keep logging in and opening another browser for other tasks (Koh et al., 2018). Second, the LMS should be able to identify and prevent students' abuse of the system, such as gaming and cheating behavior (Koh et al., 2018). Current LMS requires improvement in software design regarding the above issues in order to maintain the assessment to be fair.

To enhance the assessment for the flipped classrooms advocated by this article, some development on the LMS should be made. First, it is reported that the function of calendar builder, including course calendar, schedule, and due date management system is not commonly provided by most of the LMS (Shannon and Rice, 2017). Since monitoring students' learning process is key to the assessment approaches in flipped classrooms, the LMS should be improved by implementing a clear course schedule and be available to set deadlines for every task. This function can automatically highlight students' late submission of work, late completion of tasks, and late access to materials. It can also allow teachers to assess students' learning process more efficiently. Second, a clear indication or separation on pre-class, in-class, and post-class activities by, for example, displayed in different colors, can serve as a checklist for assessment. This design can help teachers

assess students' completion of different types of task and give feedback to students. Third, in order to fulfill different needs of providing feedback to students and to offer data for teachers' reflection, as stated above, the LMS should improve their function on analyzing and visualizing the learning analytics (Macfadyen and Dawson, 2010). Different statistic modules shall be implemented into the LMS so that teachers can obtain specific reports on students' access rate, completion rate, performance, and engagements (Romero et al., 2008). Finally, the LMS can be improved by connecting with students' mobile device. Gaftandzhieva et al. (2018) have designed a mobile learning analytics application which has the function of sending alerts on low participation rate and assessment events to students' mobile device. The early warning system would be more effective if it can employ a similar function of sending mobile push notifications to students' mobile device. The push notification can include warning messages regarding their at-risk behaviors and reminders to completing the tasks. This function would help students improve their learning process.

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