Who Benefits from Frequent Marking of Class Participation?

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Abstract

In universities, class attendance is known to improve learning, yet many students skip classes. Can instructors help students improve by frequently marking class participation? If yes, who benefits the most? Moreover, will the students who would benefit from frequent marking choose it when they are given the choice, and can universities impose frequent marking on a large scale without increases in costs? To answer these important questions, I conducted an eight-month field experiment in large second-year classes at a major Canadian university. Specifically, the experiment first allows students to express their preferences for marking frequencies relating to their class participation whether class participation is assessed every week (frequent marking) or every other week (infrequent marking). The students are then randomly assigned to the frequent and infrequent marking schemes. Findings indicate that (1) imposing frequent marking on class participation improves students performances on average if they were assigned to the frequent marking scheme; (2) the frequent marking helped the performance of low-ability and low self-control students the most; (3) when students were given the choice between the frequent and infrequent marking schemes, the ones who would benefit the most were no more likely to choose the frequent marking scheme than others, indicating they may be unaware of their problems or did not want to overcome them. These results support the use of a compulsory frequent assessment for class participation. Alongside the benefits, the costs of imposing frequent marking can be minimized by using classroom technologies that allow instructors to collect and mark students responses electronically.

1 Introduction

Prior studies show that, on average, lecture attendance is an important determinant of academic achievement in higher education; however, a significant proportion of students skip classes (Schmidt, 1983; Romer, 1993; Durden and Ellis, 1995; Dolton, Marcenaro and Navarro, 2003; Martins and Walker, 2006; and Crede, Roch and Kieszczynka, 2010).[1] The large gain of knowl-

[1]These studies recognized and tried to deal with the endogeneity problem of class attendance: students choose whether to attend lectures and this choice is affected by unobservable individual characteristics, such as ability, effort, and motivation that are also likely to determine performance. The methods employed are usually regressions by proxies, instrumental variables and panel data. However, proxies and instruments did not solve the selection bias problem due to imperfect proxies and invalid instruments. Studies using longitudinal data or micro-data are more successful. There are also a few controversial conclusions, such as Bratti and Staffolani's (2002) study, in which they found that once self-study time is controlled for, the positive and significant effect of lecture attendance for some courses disappears. In contrast, Dolton, Marcenaro, and Navarro (2003)–applying

edge from attendance and the alarmingly high rate of class skipping call for class attendance policies. However, some university students do not want class attendance to be part of the course evaluation criteria. In addition, having attendance as part of course criteria can result in extra work for the instructors because of the increased administrative load. Therefore, it is important to understand the average effects of regular class attendance and whether these effects vary by different groups of students so that the correct policy can be enacted.

While many studies indicate positive average effects of class attendance, only a few shed light on its heterogeneous effects for different subgroups of students. Among these is the randomized experiment study by Cheng and Lin (2008), who found that the average attendance effect for students who chose to attend lectures (the treatment effect on the treated) was much larger than the usual average treatment effects found in the literature (9.4 to 18 percent improvement in exam performance versus 5 percent). However, randomized experiments of mandatory class attendance policies found little to zero effects on grades (Chan, Shum and Wright, 1997 and Caviglia-Harris, 2006). These results indicate the possibility that when students who do not want to attend classes are forced to attend class, they may still not pay attention and thus have no learning improvement.

Can improvement in learning be achieved for students who skip classes? If we provide well-designed incentive scheme for class participation, will students who skip classes change their mind to attend and pay attention in class, thus experiencing an improvement in learning? As most college students have mixed motivations (i.e., they want to gain knowledge and simultaneously advance toward acquiring a college degree for the sake of future rewards), providing extrinsic incentives for class participation may achieve better motivated attendance.[2] A few recent studies found positive average effects of providing grade incentives for class participation. For example, Rassuli (2011) and Lumbantobing (2012) found that providing bonus grades for speaking up in class or participating in class group projects improve task performance. Howev-

stochastic frontier techniques to a large sample of Spanish students–found that both formal study and self-study were significant determinants of exam scores but that the former might be up to four times more important than the latter. They also found that self-study time may be insignificant if corrected for ability bias.

[2]Academic success requires exposure to learning opportunities, such as class participation. The lectures help students to identify and understand the key concepts of the subject; thus, making students think about the subject in a new way; stimulating students to think critically about the topic, and providing them an insight into what the lectures consider to be important in the subject. Students are expected to learn as long as they attend and pay attention in lectures.

er, these studies did not tell us who benefited more. Tang (2014) conducted a field experiment in large university classrooms in 2012 that randomized the weeks in which class participation counted for course grades. The results show that providing grade incentives for participation in questions in the class has heterogeneous effects on improving students' academic achievement. The effects of grading incentives on test scores are positive for one of the observed classes and for the subgroup of students with lower academic abilities (measured by prior academic achievements). The result suggests that increasing the marking frequency for class participation may improve academic achievement at least for students of lower academic abilities. However, we still do not know whether those with lower academic abilities and benefited from class participation will choose to participation in class voluntarily.

For this study, an eight-month field experiment was conducted in large classrooms of a Canadian university to answer the following questions: (1) does frequent marking for class participation increase learning through higher participation efforts in the class? (2) who benefits from the frequent marking? (3) do students, who benefit the most, choose the frequent marking when given the choice? and (4) can universities implement frequent marking for class participation without an increase in costs?

The instructors who collaborated on this study employed iClicker, a widely used classroom technology, that allows instructors to present multiple-choice questions in class and electronically collect and mark students' responses during each lecture.[3] The use of iClicker facilitated the collection of student's responses to each question in the class and largely reduced the administrative costs to instructors. The direct average cost to students is about $18 to purchase the hand-held device. Students can either buy new ones and resell it back to the bookstore or buy used ones. They can also use the device for other classes. The instructor's burden to grade is also minimized as it is done by the software. The cost left to the instructor is to make up multiple choice questions for lectures.

The first two questions of this study are whether frequent marking for class participation

[3]There are variety of names used to describe iClicker, such as clickers, zappers, personal response system, classroom response system, and electronic response system. iClicker facilitates the presentation of multiple-choice questions through PowerPoint into any classroom equipped with a digital projection system. The iClicker system requires students to purchase a handheld battery-powered device (commonly called a "clicker") with buttons, for example, marked A, B, C, D, and E, that students can use to answer questions during class. Other vendors provided cellphone apps that performed the same function.

increases learning and who benefits the most from the frequent marking. To answer these questions, the experiment design randomly divided students into a frequent marking scheme (i.e., every lecture counts for grades) and an infrequent marking scheme (i.e., every other lecture counts for grades). The group of students assigned to the frequent marking scheme was the treatment group and to the infrequent marking scheme was the control group. The students knew in advance whether a lecture counted for them or not, so they could decide whether to attend and participate in class or not, and how much attention to pay in class. If marking frequencies are not randomized but are free choices, then estimated effects of the frequent marking of class participation on students' performances would be biased. For example, good students are more likely to choose the frequent marking and attend frequently; however, they will have good course grades regardless of whether their class participation is marked frequently. Randomization, therefore, helps to disentangle the endogeneity problem of class participation: students choose whether to participate in lectures or not and this choice is affected by unobservable individual characteristics, such as ability, effort, and motivation that are also likely to determine performance. Randomization ensures that students in the frequent marking group (i.e., treatment group) and the infrequent marking group (i.e., control group) are similar in all important aspects except for the marking frequencies that they receive. The performance differences between students who are in the frequent and infrequent marking groups reveal the causal effects of the frequent marking on class participation efforts and consequently on learning. To understand who benefits from the frequent marking, data on students attributes were also collected.

The first important result of this study is that more frequent marking for class participation benefited most students. Students in the treatment group attended more classes, paid better attention in class, and obtained higher course grades than those in the control group. Second, students who did not prefer the frequent marking benefited more than those who preferred it. Lower ability or lower self-control students also benefited more than those with higher ability or more self-control.

The second question is whether students who benefit the most from frequent marking will choose it when they are given a choice. This is an important question as universities strive to provide resources to help students; however, the question remains whether the students

who may benefit from these resources will in fact make use of them. To answer this question, students in the observed classes were given a choice in the beginning of the year as to whether they want to have frequent marking. A students who prefers the frequent marking will have a 70% chance of receiving it and a 30% chance of receiving infrequent marking; whereas, a student who prefers the infrequent marking will have a 70% chance of receiving it and a 30% chance of receiving frequent marking. This study found that students with lower academic or self-control abilities were unlikely to prefer the frequent marking than students with higher abilities. In other words, the students who would benefit the most from the frequent marking did not choose it when they had the choice, indicating that they were either not aware of their problems or they did not want to overcome them. This contradicts the findings of earlier studies on self-control at work and in study (Kaur, Kremer and Mullainathan, 2014; Webb, Christian, and Armitage, 2007; Ariely and Wertenbroch, 2002). In sum, these findings indicate that, at least in the short run, providing frequent marking for class participation helped students who do not want to attend class regularly. Without the frequent marking scheme, these students perform worse than other students even to the point of risking failure in the course. Whether these results apply to other disciplines or other teaching styles require larger scale experiments across disciplines and teaching styles. Longer term effects will need follow-ups on students' future performances.

The rest of the paper is organized as follows. Section 2 discusses the experiment design and key ideas in details. Section 3 provides information on data summary. Section 4 discusses the empirical analysis and presents main results. Section 6 provides a conclusion and suggestions for future study.

2 The Experiment Design

The experiment design involved class participation grades, which counted for 7 to 10 percent of students' total class grades. A student needed to participate in multiple-choice questions in class to earn the class participation grade. A classroom technology, iClicker, was employed by instructors to electronically record and grade students' responses to class questions, which largely reduced the administrative loads. Students needed to purchase and use a hand-held

device to answer questions in the class.

The participation mark of each iClicker question was decided by instructors and was divided into two parts: students could earn half of the mark if they came to class and used their iClicker for questions regardless of correctness (hereafter the participation mark), and students could earn the rest of the mark if they answered the questions correctly (hereafter the correctness mark). The participation mark encourages students to show up in class and participate in questions since they could earn at least half of the iClicker marks by attending and clicking alone. The correctness mark encourages students to critically think about and solve the questions, which in turn could increase learning. As indicated by the earlier study of Tang (2014), the provision of the two-part grade incentive is expected to increase or at least not decrease participation efforts in the class for different types of students, which in turn increasing learning.[4]

The goal of this study is to understand whether frequent marking of class participation has casual effects on learning. A major inference problem is selection bias, in which students with certain characteristics may prefer and choose frequent marking of class participation, however their characteristics may be the driving force that cause them to have good grades regardless of marking frequencies. Using data from one of the experimented class as an example, a second year quantitative class, we can see that there is a positive correlation between the class participation rate and course grades as shown in Figure 1, indicating regular class participation may be effective in increasing learning. However, Figure 2 and 3 show the inference problem. That is, students with higher academic achievement (measured by cumulative grade point value, hereafter the cumulative GPA) are more likely to participate in classes and also have higher course grades. If marking frequencies are choices rather than random assignments, then students with high cumulative GPAs may be more likely to choose the frequent marking. The simple mean comparison of performances between those who receive and do not receive the frequent marking will be biased upwards since good students chose and receive the treatment but they tend to do well regardless of marking frequencies.

If we only want to understand whether frequent marking of class participation will increase

[4]Students have, but not limited to, following channels to improve learning: they can learn by going through the critical thinking process to solve questions; through discussing with neighbouring students; and through feedbacks provided by instructors right after they submit their answers.

learning on average, then we can randomly assign half of students to a frequent marking scheme (i.e., participation in every lecture counts for grades) and the other half to an infrequent marking scheme (i.e., participation in every other lecture counts for grades, specifically, even- or odd-week lecture counts). That is, a simple randomized controlled trial is enough. The random assignment of marking frequencies ensures that students in the frequent marking scheme (i.e., treatment group) and the infrequent marking scheme (i.e., control group) are similar in all important aspects (i.e., pre-treatment characteristics) except for the marking frequencies that they receive. If the random assignment is successful, then the causal effects of the frequent marking are revealed if there is statistically significant differences in performances between the two groups.

The two schemes had the same total participation mark in the same class (7 to 10 percent of course grades in the two experiment classes, respectively). They, however, differed in the marking frequencies for class participation. Under both schemes, students needed to attend and participate in classes on regular basis, but students in the treatment group needed to participate in about twice as many lectures to earn the same class participation grade as those in the control group. Therefore, some students may not want the frequent marking. We want to understand (1) whether students prefer or do not prefer the frequent marking and (2) whether students who do not want the frequent marking will benefit more or less from it than those who prefer it. To understand this, the experiment design had two steps: step one reveals students' true preferences for marking frequencies (i.e., preference elicitation), and step two randomly assigns marking frequencies within each preference type (i.e., randomized control trial by preference types). Specifically, in the beginning of the course, students were given the choice as to whether they want to have frequent or infrequent marking schemes. Students can choose between two lotteries: Lottery A had a higher chance (70%) of getting assigned to the treatment group (i.e., frequent marking scheme) and a lower chance (30%) of getting assigned to the control group (i.e., infrequent marking scheme), and it was the opposite for Lottery B. Students were told that their final assignment of marking schemes would be randomly assigned based on the probabilities of the lottery they chose. They were also told that their choices of lotteries would not be known to instructors and instructors would only know their final assignments of marking schemes. Thus we could reasonably assume that the majority of students would

choose the lottery type that truly reflects their preferences for frequent or infrequent marking schemes. After the lottery choices, students were randomly assigned into the two types of class-participation marking schemes based on the probabilities of the lotteries they chose. The randomization of marking frequencies is thus stratified by students' preferences. This design helps us to understand the heterogeneous causal effects of frequent marking on learning for students who want or not want the frequent marking.

Other than the experiment design, this study also collected data on students' attributes. These attributes include measures of students' academic achievements before this study (e.g., cumulative GPA, average score of prerequisite courses, number of classes failed before), students' demographic information (e.g., age, gender, year of study, parents' education, first language, program of study), as well as survey measures of self-control, motivation, risk aversion and personal difficulties in attending classes.[5] As indicated by earlier studies, these observable (i.e., students' prior academic achievements and demographic information) and unobservable variables (i.e., measures of self-control, motivation, risk aversion and personal difficulties in attending classes) are likely to correlate with the preferences of marking frequencies and students' academic performance. Given the preferences, random assignments of marking frequencies and the information collected on students' attributes, we are able to study two things: we can study the correlation between students' preferences and their attributes; we can also study the different effects of the frequent marking among students with different attributes.

So who will prefer the frequent marking? It was expected to have a mixture of students with different characteristics, personalities and personal situations. Earlier studies on self-control at work or in study suggest that students who are aware of their self-control problems (i.e., they do not work or study as hard as they would like to) are more likely to choose Lottery A, i.e., prefer frequent marking (Kaur, Kremer and Mullainathan, 2014; Webb, Christian, and Armitage, 2007; Ariely and Wertenbroch, 2002). The reason is that if students who lack self-control are sophisticated, then they know that they will be very likely to miss classes when the term work gets busy or when they are lazy. This is because the value of grade return of class participation becomes smaller in comparison to the cost of participation when the lecture day is closer than when it is further away. Being assigned to the frequent marking scheme forces them to attend

[5]If you need copies of surveys, please contact Lei at lei.tang@mail.utoronto.ca.

and pay attention in more classes and thus benefit from the increased learning.[6] Other types of students may also prefer the frequent marking. For example, students who are risk averse may be more likely to prefer the frequent marking scheme. This is because the maximum grade per lecture under the frequent marking scheme is about half than that of the infrequent marking scheme. If a student has to skip a graded class, then the grade loss is smaller under the frequent marking. Students with higher motivation may also prefer frequent marking as they want to push themselves to try hard to answer questions in every class. Moreover, students who have job, social or extracurricular commitments, family obligations; or longer travel distances to school may be less likely to prefer frequent marking. Students with better prior academic performance may not prefer frequent marking as they usually will attend classes. So who will benefit more from the frequent marking? The study found that students who do not prefer the frequent marking and with lower self-control or academic abilities will benefit more.

In sum, there are four groups of students after the random assignment of marking schemes and lottery choices: students who prefer the frequent scheme and are assigned or not assigned to the frequent marking; and students who prefer the infrequent scheme and are assigned or not assigned to the infrequent scheme. The performance difference between the treatment and control group within each preference type is the heterogeneous causal effects of the frequent marking by preference types. This helps us understand whether students who do not prefer the frequent marking benefited more or less from it than students who prefer it. Moreover, the data collection of students' prior academic performance, demographics, personalities, and personal difficulties help us understand who prefers the frequent marking and the performance difference due to frequent marking among students of different prior academic achievements or other students' attributes.

[6] In the time-inconsistent agents' model, students who are time-inconsistent are modeled as agents who discount the future using hyperbolic discount rate. To these students, the relative gain in the future to the cost becomes lesser when the day of the cost arrives than the day of the cost is further away. If these students are sophisticated, then they know that they will be less likely to attend a class when the day comes than in the earlier times. They thus would like to put constraints on the attendance in order to increase the likelihood of actual attendance.

3 Data and Summary Statistics

The experiment was conducted at a large Canadian public university. The experiment involved 157 students enrolled in one section of an intermediate Microeconomics course (hereafter Micro class) and 641 students enrolled in four sections of an intermediate Quantitative Methods class (hereafter Quant class) during the 2014-2015 calendar year. The course length was eight months with 24 regular class meetings, each being two hours long.[7]

During the first week of class, students received their syllabus informing them about the chance of voluntary choices of lotteries that determines their assignments of marking frequencies for their class participation. In week three, students submitted their choices of lotteries that offer different chances to be assigned to one of the two marking schemes. Among students who chose Lottery A (i.e., prefer frequent marking), 70 percent of them will be assigned to the frequent marking and 30 percent will be assigned to the infrequent marking scheme, and vice versa for those chose Lottery B. Students were told that their instructors will not be told their preferences about the marking frequencies. Their preferences were collected by the principal investigator and the random assignment of marking frequencies was also done by the principal investigator. The only information the instructors knew was the final assignment of marking schemes for grading purpose. It is thus reasonable to assume that majority of students' choices reflected their true preferences for marking frequencies. Figure 4 shows that about 70 and 55 percent of students preferred the frequent marking in the Quant and Micro classes, respectively. The most important reason for preferring the frequent marking was that "Class attendance is important to me. Getting graded more often will encourage me to come to class and/or pay better attention", followed by 28 and 39 percent of students who preferred the frequent marking because the per-lecture loss is lower under the frequent scheme if they miss one. For students who preferred the infrequent scheme, the top reason is "I try to attend lectures and usually do, missing them from time to time for academic, extracurricular, or personal conflicts. The infrequent marking scheme makes it easier for me to manage my schedule", followed by the reason "there is less pressure under the infrequent marking scheme". There were also about 10

[7]The lecture times were on Wednesdays from 10 a.m. to 12 p.m. for the Micro Class and one section of the Quant class, and on Tuesdays from 10 a.m. to 12 p.m., from 2 p.m. to 4 p.m., and on Wednesdays from 2 p.m. to 4 p.m. for the other three sections of the Quant class. Students in the Quant class were allowed to attend and switch between any sections for lectures.

percent of students who viewed class participation as not important. Given various reasons for the preference choices, it is important to explore the characteristics of students in each of the preference groups, which will be shown in Section 5.

During the third lecture, students also signed the consent forms voluntarily to allow the collection of their experiment and academic data. The consent rates were about 92 and 77 percent in the Quant and Micro classes, respectively. The final numbers of students who consented and for whom data from the registry office was collected were 590 and 121 from the Quant and Micro classes, respectively. The Quant class thus had much larger class size than the Micro class. Among students who consented for data collection, the non-dropouts were 468 and 100 students in the Quant and Micro class, respectively. In other words, the attrition rates among those we collected pre-treatment data was about 17 to 21 percent. For a randomized trial, we want to make sure there is no attrition bias due to subjects drop out of the treatment in a systematically way. T-test is conducted to verify whether there is statistically significant difference in dropout rates between students who are assigned to the treatment and control group. Panel A and B of Table 1 show the differences in average dropout rates between those who were assigned and not assigned the treatment, and the p-values that testing whether the mean differences are statistically significant for the Quant and Micro class, respectively. Panel B shows that, for the Micro class, there is no statistically significant difference in the dropout rates between those assigned and not assigned the treatment. However, Panel A shows that students who were assigned the treatment is about 8 percent less likely to drop out than those who were not assigned the treatment and the difference is statistically significant at conventional significance level (i.e., the p-value is smaller than 5 percent). When we divide students into those who preferred and did not prefer the frequent marking, we can see that the statistically significant difference comes from the students who preferred the treatment. This indicates that in the Quant class, students who preferred the treatment but were not assigned it might be discouraged. It is thus important to check whether there are statistically significant differences in students' characteristics between the dropouts and non-dropouts.

Panel A and B of Table 2 show, for the Quant and Micro class, the mean differences in students' pre-treatment characteristics between those who dropped out and did not drop out of the class. We can see that when we include all students, there is no statistically significant

differences between dropouts and non-dropouts in almost all pre-treatment characteristics except for the measure of self-control. In both classes, dropouts had slightly higher self-control abilities than non-dropouts. When we divide students into four groups by their preference for and assignment of marking schemes, we can see that the differences come from the students who preferred the frequent marking but were not assigned it in the Quant class,[8] but from those who preferred it and got it in the Micro class.[9] The implication for the treatment effects could be as follows. For the Quant class, the treatment effects for those who preferred the treatment could be biased upwards since the control group should have more students with better self-control if there was no dropouts and if we assume students with better self-control perform better than those with more self-control. The reverse holds for the Micro-class students who preferred the treatment since the treatment group lost students with better self-control. The biases should small though since the magnitudes of differences in characteristics are small. Lastly, for students who remained in the sample, it is important to check whether the treatment and control group had statistically significant differences in pre-treatment characteristics (i.e., whether the random assignment was successful). These results will be shown in the relevant sections that present the estimation of treatment effects.

For the rest of the weeks, each lecture required students to use iClicker to answer questions in the class. For a graded lecture, students earn half of the marks of a class question if they participate by using their clickers and earn the rest of it if they answer the question correctly. If a student did not attend or participate in any questions that day, he/she earns zero marks. This study only observed whether students attended and participated in class and thus cannot separate the effects of class attendance and class participation. Students were randomly assigned to the frequent and infrequent marking scheme according to the probabilities of lotteries they chose. Among students who consented for data collection and did not drop out of the Quant class, 39 percent and 61 percent were assigned to the infrequent and frequent marking, respectively. These rates were 41 percent and 59 percent in the Micro class. For students who were assigned the frequent marking scheme, class participation counted for grades in 22 lectures

[8]For the Quant class, the mean value of self-control measure is 0.04 and the standard deviation is 1.94, with the minimum and maximum equal to -5 and 5.

[9]For the Micro class, the mean value of self-control measure is -0.01 and the standard deviation is 1.51, with the minimum and maximum equal to -5 and 7.

in the Quant class[10] and counted in 23 lectures in the Micro class[11]. For students who were assigned the infrequent marking scheme (either odd- or even-week sequence), class participation counted for grades in 13 lectures in both classes. The total iClicker grade was 10 percent of the overall course grades in the Quant class and 7 percent in the Micro class. As a result, the maximum grade per graded lecture under the frequent marking was 0.45 and 0.3 percent of the overall course grade in the Quant and the Micro class, respectively; and 0.77 and 0.53 percent of the overall course grade under the infrequent marking scheme. The Quant class thus had higher grade incentives than the Micro class.

There were also other differences between the two classes as reported in Table 3. The table summarized the means and standard deviations of the pre-treatment student characteristics for two classes. Mean and variance tests show that, compared to the Micro class, the Quant class had higher average and smaller variance in the cumulative GPAs. The t-test of whether average cumulative GPAs of the Quant class is larger than that of the Micro class yields a p-value of 0.0000. The F-test of whether the variance of cumulative GPAs of the Quant class is smaller than that of the Micro class yields a p-value of 0.0018. Moreover, the Quant class had a majority of students in the Bachelor of Commerce program (about 78 percent) compared to the Micro class that had a majority of students in Bachelor of Science (about 63 percent) and Bachelor of Arts (about 35 percent) programs. Alongside of the differences between the two classes, there were also many similarities between them: the majority of students in the sample were full-time students and arts and science students. The average year of study was the second year. About 60 percent of the students were female. About 60 to 70 percent of students' first language was not English, and around 60 percent of students' fathers or mothers had a 4 year undergraduate or higher education in both classes. In sum, the Quant class had more uniform and better students than the Micro class, as well as a larger grade incentive for class participation and larger sample size. This may explain the later regression results that the frequent marking scheme has stronger effects on performance in the Quant class than in the Micro class.

Other than the above observable student characteristics, this study also collected survey measures of personalities and personal situations, which may be driven forces underlying s-

[10] excluding the first lecture of the Fall and Winter term
[11] excluding the first lecture of the Fall term

tudents' preferences and performances. Table 4 summarizes survey measures of self-control, motivation, risk aversion, and personal difficulties in attending classes. First, about 32 and 29 percent of students responded to have one or more of the following major obstacles to attend lectures in the Quant and Micro classes, respectively: work or financial commitments, family obligations, traveling time to school, and social or extracurricular commitments. Second, I gathered measures of risk aversion based on the survey developed by Holt and Laury (2002). Risk aversion is measured by the number of safe choices made in 11 decisions between risky and safe lotteries. The higher the number of safe choices, the more risk averse a student is. Alternatively, risk aversion is also measured by a question of general risk attitude, "In general and on a scale from 0 to 10, how willing are you to take risks? 0 means unwilling to take risks and 10 means being fully prepared to take risks". The larger the number, the less risk averse a student is. Table 4 indicates, on average, students are risk neutral (i.e., the number of safe choices and general risk attitudes are around 5), but there is a large variation in the level of risk aversion among the students in the study.

Third, two commonly used measures of self-control were collected: IE gap and IPIP self-control. The IE gap measure is based on the questionnaire of Ameriks, Caplin, Leahy and Tyler (2002), where people are given hypothetical coupons to be used within two years. IE gap is the difference between the ideal consumption and the expected consumption in year one. The larger is the difference, the less is the self-control problem.[12] Another self-control measure, IPIP self-control, is based on the existing psychology inventory, the International Personality Item Pool[13]. It is a single number by summing over positive and negative items. The larger is this number, the less is the self-control problem. We can see from the individual items of the IPIP questions listed in Table 4 that there are a considerable amount (i.e., around 30 to 40 percent) of students who agree or strongly agree with the statements that indicate them as having self-control problems.

Motivation could also be a driving factor for students' preferences and performances. The measure of motivation is also based on the existing psychology inventory of the personality

[12]There may be corner cases that make the measure either right or left-truncated. I did not deal with it since there are very few corner cases.

[13]The IPIP self-control measure is based on the long-form survey from http://ipip.ori.org/. International Personality Item Pool (IPIP) website is a free online resource that provides access to measures of individual differences. Measures are developed conjointly among scientists worldwide.

questionnaire from the International Personality Item Pool (http://ipip.ori.org/), and is used to measure the overall motivation of a student. It is a single number generated by summing over positive and negative items. The larger the number, the more motivated a student is. From the individual items listed in Table 4, we can see that more than half of the students agree and strongly agree that they have the motivation to work hard, carry out plans, and demand quality. Less than 20 percent of students agree or strongly agree that they are highly motivated to succeed, to do just enough work to get by, or to put little effort into work. These simple summaries indicate that we have diverse types of students and this may complicate the interpretation of preferences towards the frequent scheme as a clean measure of one kind of student characteristics. It is thus important to study correlations between these survey measures and preferences, as well as the different effects of the frequent marking among students of different attributes.

4 Treatment Effects of and Preferences for the Frequent Marking

In this study, the causal effect of frequent marking (i.e., the treatment) on performance is established by the random assignment of marking frequencies. The experiment design randomized the treatment and control group within each preference type. Thus the causal interpretation of the effects of the frequent marking on performances are established for each preference type. The following subsections summarize and present the regression results that focus on (1) the average differences in various performance measures between the frequent and infrequent marking group, (2) the performance changes under the frequent marking among students of different preferences, characteristics or personalities, (3) as well as who preferred the frequent marking. The sample of the analysis includes students who consented for data collection and did not drop out of the class. As the dropouts were not included in the sample analysis due to missing observations on their outcomes, the results of the analysis may not be generalized to these students. If we include dropouts, the average effect of frequent marking could be smaller or larger depends on the characteristics of dropouts and whether they were in the treatment or control group before they dropped out. As shown in the Panel A of the earlier Table 2, non-

dropouts who preferred but were not assigned the treatment in the Quant class had statistically significantly lower self-control abilities than dropouts. If students with more self-control will have smaller performance changes under the frequent marking than those with less self-control, then including dropouts with more self-control back to the control group where they dropped out of should reduce the estimated treatment effects. In contrast for Micro class, the treatment effect should be biased downwards since it was non-dropouts who preferred and assigned the treatment had statistically significantly lower self-control abilities.

4.1 Average Treatment Effects

To answer the question of whether frequent marking increases performance on average, this study investigates the mean performance differences between students who were and were not assigned the frequent marking. The main analysis simply regresses performance measures on the indicator of whether a student was assigned the frequent marking.

$$Perform_i = \alpha + \beta_1 Frequent_i + \epsilon_i \tag{1}$$

The binary variable of the frequent marking indicator, $Frequent_i$, is equal to 1 if a student was assigned the frequent marking scheme and 0 otherwise. The dependent variable, $Perform_i$, is one of five performance measures, namely, class participation rates[14], iClicker scores (i.e., proxy for effort in the class), final exam scores, overall course grades with or without iClicker scores. These dependent variables are all in percentages and on 0 to 100 scales. Since the frequent marking indicator, $Frequent_i$, is randomly assigned within each preference type (but not with all students pooled together) and 70% of students within each preference type get what they want, it is thus correlated with students' preferences. Therefore, by pulling all students together, the performance difference between the frequent and infrequent marking group can be interpreted only as the correlation between the frequent marking and the performance. However, it is still worth to check if students in the treatment and control are similar in some important

[14]In this study, I observe class participation rather than attendance. Participation was recorded when a student not only attended, but also participated in class questions. The effect of attendance by those who do not want to attend may be lesser than those who attend, but the effect of class participation may be larger for them since participation in iClicker questions requires active and critical thinking, which increases learning. Feedback provided by instructors immediately after collecting students' responses may also increase learning.

pre-treatment characteristics when we pool all students together. Table 5 shows the average values of the collected pre-treatment characteristics of the frequent and infrequent marking group (i.e., the treatment and control group), as well as p-values of the t-tests of whether these average values are equal between the frequent and infrequent marking group. We can see from Panel A of the table that students in the treatment group and control group are not statistically different in pre-treatment characteristics and personality measures since p-values are all above the conventional significance levels. Therefore, the treatment and the control group are similar in many important aspects in the Quant class. For the Micro class, however, the treatment and control group is almost balanced in many characteristics except that the treatment group had more female students and higher levels of motivation (see panel B of the table). If these characteristics are correlated with both the treatment and performance measures, then the estimated effects of frequent marking in the Micro class may be biased. The bias will be more likely upwards if good students in the treatment group will do well regardless of the marking frequencies. Robustness check will compare results of the main regression specified in Equation (1) with results of specifications that include student attributes.

Each column in Panel A of Table 6 presents the effects of the frequent marking on one of the five performance measures in the Quant class. On average, being assigned to the frequent marking scheme increased class participation by about 12 percent (about 3 out of 24 classes), increased the iClicker scores in the class (i.e., class participation scores or participation efforts) by about 3 percentage points, increased the average test-scores by 8 percentage points, the final-exam scores by 10 percentage points, and course grades by 7 and 6 percentage points with and without iClicker score, respectively. The results for the Micro class are similar but with weaker statistical significance, except that the average class participation rate was increased much more than that of the Quant class (see Panel B of Table 6). These results are also robust to the inclusion of other students characteristics (see Table 7).

These results show that, on average, students participated in more classes and tried harder to answer questions if they were assigned the frequent marking scheme than if they were not. They also achieved higher course grades.[15] However, there is no statistically significant increase

[15]People may worry about the spillover effects of the frequent marking since the randomization is done within the class. In this class, the sample size of students who were not assigned the frequent marking was smaller than that of students who were assigned the frequent marking, thus students who were not assigned the frequent

in self-study times caused by the assignment of the frequent marking scheme as shown by Table 8. This may be because self-study is not a complement to class participation, or due to measurement errors of self-reported survey measures. These results indicate the possibility that the frequent marking scheme increased learning through increased class participation rate and effort. Will these effects be different for students with different preferences for marking frequencies, academic abilities, personalities, or situations? Following subsections will provide answers to these questions.

4.2 Treatment Effects by Preference Types

Results of the study by Cheng and Lin (2008) indicate that the average attendance effects for students who voluntarily choose to attend lectures (treatment effect on the treated) is much larger than the usual average treatment effects found in the literature. Will students who do not want to regularly participation in class perform worse than those who want it? Will they be helped by the assignment of frequent marking?

The following results are based on the regression of five performance measures on the indicator of the assignment of the frequent marking scheme, $Frequent_i$, the indicator of the preference for the frequent marking, $Prefer_i$, and the interaction of the two.

$$Perform_i = \alpha + \beta_1 Frequent_i + \beta_2 Prefer_i + \beta_3 Frequent_i \times Prefer_i + \epsilon_i \qquad (2)$$

There are three effects of interest. First, the estimated coefficient ($\hat{\beta}_2$) of the indicator of whether a student preferred the frequent marking tells us that when not assigned the frequent marking scheme, what would be the difference in the performance of students who preferred it relative to those who did not. Second, the estimated coefficient ($\hat{\beta}_1$) of the indicator of whether a student was assigned the frequent marking captures the causal effects of frequent marking on performances among students who did not prefer it. Since the frequent marking is randomly assigned within each preference group, the indicator of the frequent-marking assignment, $Frequent_i$, is thus not correlated with unobservable characteristics of students, such as ability, self-control, motivation, and effort (i.e., $corr(Frequent_i, \epsilon_i) = 0$) if the preference indicator is

marking may increase their class participation as many other students participate frequently. However, this would bias the treatment effects downwards rather than upwards.

included. This can be verified by the balance test of whether there are significant differences in the pre-treatment student characteristics between the frequent and infrequent marking group for each preference type, which is shown in the next paragraph. Third, the estimated coefficients ($\hat{\beta}_3$) reveals that, compared to students who did not prefer the frequent marking, whether students who preferred it had more or less improvement in performance if they were assigned the frequent marking scheme than if they were not. This specification yields the heterogeneous causal effects of frequent marking by students' preference types.

Firstly, we need to check whether students in the treatment group (i.e., frequent marking group) and the control group (i.e., infrequent marking group) are comparable. That is, whether they are similar in important aspects except for the treatment they receive. For the Quant class, Panel A and B of Table 9 show the mean values of the pre-treatment characteristics and the p-values of t-tests of whether these mean values are equal between the treatment and control group for students who preferred and did not prefer the treatment, respectively. For the Quant class, the randomization of the assignment of the frequent marking scheme was successful within each preference group since the p-values are all above the conventional significance levels. That is, the treatment and control group were comparable within each preference type except for the treatment they received. Therefore, for the Quant class, the performance differences we observe between the frequent and infrequent marking group within each preference type are the causal effects of the frequent marking. For the Micro class, however, students who preferred the frequent marking had more female students and better students in the treatment group relative to the control group in terms of less students failed courses before and students with higher motivation measures[16] (see Panel C and D of 9). Therefore, the estimates of the treatment effects in the Micro class may be biased upwards since there are more good students in the treatment group and if we assume that good students will do well regardless of the assignment of marking frequencies.

Panel A of Table 10 presents the performance changes caused by the frequent marking assignment for students who preferred or did not prefer it in the Quant class. Firstly, we can see from the second row of Panel A that if students were not assigned the frequent marking, those who preferred it had higher class participation rates (78 versus 63 percent), iClicker

[16]P-values of the mean difference tests are all below 10 percent significance levels

scores (75 versus 70 percent), average of test scores (57 versus 48 percent), final exam scores (53 versus 42 percent), and course grades with or without iClicker scores (68 versus 56 and 61 versus 49) relative to those who did not prefer it.[17] These differences are statistically significant at 1 percent significance level. This result indicates that students who preferred the frequent marking will perform better than those who did not prefer it when there is no frequent marking scheme. Therefore, students who did not want the frequent marking need more help than those who preferred it.[18] But will students who did not want the frequent marking be helped more if they were assigned it than those who wanted it?

The first row of the Table shows that for students who did not want the frequent marking, their performances were statistically significantly increased to above the class average levels if they were assigned the frequent marking. Specifically, the assignment of frequent marking increased their class participation rate from 63 to 83 percent, iClicker score from 71 to 76 percentage points, average of test score from 48 to 61 percentage points, final exam score from 42 to 60 percentage points, overall course grade from 56 to 70 percentage points, and course grade without iClicker score from 49 to 63 percentage points. In contrast, when we add up the values of the first and the third row of the Table, we can see that the frequent marking increased performances much less for students who preferred it. The treatment effects of frequent marking on course grades even become statistically insignificant for them. The magnitudes of increase in performances of those who did not want the frequent marking is more than double the size of that of those who wanted it. The differences in the treatment effects between those who wanted and did not want it are statistically significant at 1 to 5 percent significance levels.

In sum, for students in the Quant class, those who did not want the frequent marking performed worse than students who wanted it if there they were not assigned the frequent marking. Their average course grade was at the margin of failing the course and thus needed the most help. The assignment of frequent marking increased their performances above the course averages. In contrast, the treatment effects are much smaller for students who wanted it and become statistically insignificant in term of course grades. However, the results in the

[17] Test and exam scores are raw scores before adjustments.

[18] The performances of students who did not prefer frequent marking was much lower than the average performances of the class while the performances of those who preferred it is about to equal to the class averages (see Table 11). The course grades of those who did not want it and were not assigned it is at the margin of failing the course.

Micro class are different (see Panel B of Table 10). First, students who preferred the frequent marking did not statistically significantly outperform those who did not prefer it when there were not assigned it. In addition, although the assignment of frequent marking increased the class participation rates of those who did not prefer it, it did not statistically significantly increase test or exam scores. In contrast, it statistically significantly improved the course grades of those who preferred it. The improvement for those who preferred it may be explained by the fact that there are more better students in the treatment than control group among those who preferred the frequent marking (as shown earlier in Table 9). These results are robust to the inclusion of other student characteristics.

4.3 Treatment Effects by Prior Academic Achievement

This section presents the heterogeneous effects of frequent marking on performance measures among students of different observable characteristics, such as prior academic performance and demographics. The following regression is used to study the heterogeneous treatment effects by levels of cumulative grade point (hereafter cumulative GPA). The cumulative GPA is a measure of students' academic achievements before this study. It is the average score of all the courses a student have taken converted into a scale of 0 to 4.

$$\begin{aligned} Perform_i = \alpha + \beta_1 Frequent_i + \delta_1 CGPA_i^1 + \delta_2 CGPA_i^2 + \delta_3 CGPA_i^3 \\ + \eta_1 Frequent_i \times CGPA_i^1 + \eta_2 Frequent_i \times CGPA_i^2 \\ + \eta_3 Frequent_i \times CGPA_i^3 + \epsilon_i \end{aligned} \tag{3}$$

The dependent variables are the same as before. The variables of interest are the indicator of whether a student was assigned the frequent marking, $Frequent_i$, categories of cumulative GPAs, and the interaction of the frequent marking indicator and categories of cumulative GPAs. I divided the students into four categories of cumulative GPAs. $CGPA_i^1$ is for students in the lowest category of CGPAs, and so on.[19] The omitted category in the regression analysis is the

[19] $CGPA_i^1$ equals 1 if cumulative GPA is below 2.5 and equals 0 otherwise; $CGPA_i^2$ equals 1 if cumulative GPA is between 2.5 and 3 and equals 0 otherwise; $CGPA_i^3$ equals 1 if cumulative GPA is between 3 and 3.5 and equals 0 otherwise; $CGPA_i^4$ equals 1 if cumulative GPA is above 3.5 and equals 0 otherwise. According to the grading policies of University of Toronto, $CGPA_i^1$, $CGPA_i^2$, $CGPA_i^3$, $CGPA_i^4$ are equivalent to students having a letter grade of C or below, between C+ and B-, between B and B+, and A- or above, respectively. The cumulative

highest category of cumulative GPAs.

There are three effects of interest. First, the estimated coefficients of the different levels of cumulative GPAs ($\hat{\delta_1}$, $\hat{\delta_2}$, $\hat{\delta_3}$) reveal–when students were not assigned the frequent marking, what would be the difference in the performance of students with different levels of cumulative GPAs relative to students in the highest category of cumulative GPAs. Second, the estimated coefficient ($\hat{\beta_1}$) of the indicator of whether a student was assigned the frequent marking, $Frequent_i$, captures the effect of frequent marking on performance of students in the highest category of cumulative GPAs. Third, the estimated coefficients of the interaction terms ($\hat{\eta_1}$, $\hat{\eta_2}$, $\hat{\eta_3}$) reveal that whether students in the lower categories of cumulative GPAs had more or less improvement in performance than students in the highest category of cumulative GPAs when they were assigned the frequent marking than they were not.

In this study, the treatment is not designed to be randomly assigned by levels of cumulative GPA. The performance changes among students of different levels of cumulative GPA may be biased measures of treatment effects if the assignment of frequent marking within each CGPA level is systematically correlated students characteristics, such as self-abilities, that are also correlated with performances. To investigate the possible direction of bias, Panel A and B of Table 12 try to check, for the Quant and Micro class, whether students' collected attributes are similar between those assigned and not assigned the frequent marking within each cumulative GPA level. Both tables show the average values of students characteristics and p-values of t-tests that testing whether these mean values are equal between those assigned and not assigned the frequent marking. Both tables show that, for each level of cumulative GPA, the treatment and control group did not have statistically significant differences in students characteristics. One exception is that, in the Micro class, among students with CPGAs between 2.5 and 3, those who were assigned to the frequent marking group are more risk-averse than those who were not assigned it. Therefore, the bias in the estimation of treatment effects should be small.

Panel A of Table 13 shows the results of the regression specification in equation (3) for the Quant class. First, the second to fourth rows of the table show that, when students were not assigned the frequent marking scheme, student with lower cumulative GPAs performed statistically significantly worse than students with the highest cumulative GPAs. That is,

GPAs are divided with the aim to have comparable sample sizes across different levels of cumulative GPAs.

there was a strong positive correlation between the cumulative GPAs (i.e., the measure of prior academic achievement) and various performance measures. On average, students in the lowest category of the cumulative GPA participated in only about 55 percent of the classes if they were not assigned the frequent marking scheme. Their average course grades were at the risk of failing the course (i.e., below 50 percentage points). These students needed the most help. Had they been helped by the assignment of frequent marking? Had their performances been improved more than students with higher CGPAs?

Firstly, the first row of Panel A shows that students with cumulative GPAs above 3.5 (i.e., with letter grades of A- and above) did not have statistically significant increase in class participation rates, iClicker scores and test scores, except their course grades were reduced by about 4 percentage points at 10 percent significance level. Secondly, the row (5) to (7) of the table show that comparing to students in the highest category of cumulative GPA, students with lower cumulative GPAs was helped more by the frequent marking. Students with CGPAs below 3 (i.e., with letter grades of C or below) were helped the most. For example, the assignment of frequent marking increased their class participation by about 20 percent (about 5 out 24 lectures), iClicker grades by about 5 percentage points, average of test scores by about 19 percentage points, final exam scores by about 23 percentage points and course grades with and without iClicker scores by about 18 and 17 percentage points, respectively. These increases are statistically significant at 1 percent significance level. Comparing to the average course grade under the infrequent marking, the assignment of the frequent marking scheme pulled these students with the lowest CGPAs far away from failing the course. Students with higher CGPAs were also helped by the assignment of frequent marking but to smaller magnitudes. These regression results are robust to the inclusion of other observable characteristics, such as gender, year of study, parents' education, and first languages. The results are also robust to include continuous cumulative GPA. This result indicates that, in the Quant class, students with lower prior academic achievement (or lower academic ability) benefited more from frequent marking. For the Micro class, Panel B of Table 13 shows that students in the lowest category of CGPA performed much less than those with the highest category of CGPA, which is similar as in the Quant class. However, their performances were not statistically significantly improved by the frequent marking except that their class participation rate were statistically significantly

improved by about 12 percent. Similar results hold for students in other categories of CGPAs. This indicates that, in the Micro class, the assignment of frequent marking increased class participation rates, but did not increase learning. These results are in sharp contrast to that of the Quant class. One possible explanation could be that the Micro class had small sample and smaller grade incentives than the Quant class. Another explanation could be that the effects of frequent marking is different across contexts since the Micro and Quant class had many differences in terms of students attributes, course contents and teaching styles.

4.4 Treatment Effects by Self-Control Abilities

Earlier studies on self-control found that self-imposed constraints in study or at work increased task performance of people who lacked self-control but wish to overcome it by committing to costly constraints (Kaur, Kremer and Mullainathan, 2014; Webb, Christian, and Armitage, 2007; Ariely and Wertenbroch, 2002). These results imply that, on average, (1) students lacking self-controls are sophisticated enough to realize their problems and prefer the costly frequent marking scheme to motivate their future selves; (2) these sophisticated students who seek for help will be helped.[20] This section presents the analysis results that try to verify whether students with lower self-control abilities were helped by the frequent marking (i.e., costly constraints on class participation). Next section will show analysis results that try to verify whether students lacking self-control preferred the frequent marking when they were given the choice.

To investigate the effects of the frequent marking among students of different self-control abilities, this study regresses the five performance measures on the indicator of whether a student was assigned the frequent marking, the levels of self-control abilities, and the interactions of the two. The self-control ability is measured by the IE-gap[21] and is divided into five cate-

[20] In these earlier designs, people who wish to have work or study constraints get what they planned for if they were offered the free choice. When comparing the performance of people who were offered the free choice to people who were not offered the choice, the authors compared the weighted average performance of students who chose to be treated and were treated, and those who chose otherwise and thus not treated to the average performance of students who were not offered the choice and thus not treated. The difference will be bigger for people with low self-control than for those with high self-control even if the treatment effects are the same for both types. The reason is that higher proportion of low self-control people chose to be treated and lower proportion of high self-control people chose to not be treated. In contrast, the design of this study had randomization of treatment among students who prefer or not prefer it.

[21] See section 3 for details about IE-gap.

gories. The smaller is the magnitude of the IE gap, the more severe is the self-control problem. Students with the least self-control have an IE gap smaller than -2 and students with the most self-control have an IE gap greater than 2.

Panel A of Table 15 shows the different effects of the frequent marking among students of different levels of self-control measures in the Quant class. Firstly, row 2 to 5 of Panel A show that, among students in the control group (i.e., infrequent marking group), students with lower self-control abilities (i.e., smaller IE gap measures) performed worse than those with higher self-control abilities at 1 to 10 percent significance levels. For example, on average, students with the least self-control participated in 15 percent less of lectures (i.e., about 4 out of 24 lectures) than students with the most self-control. They also had about 12 percentage points lower of course grades than students with the most self-control, which was equivalent to have about 0.44 standard deviation lower than the class average.[22] So did the assignment of frequent marking helped students and whether those with less self-control benefited more from it? From row 1 of Panel A, the assignment of frequent marking did not increase performances of students with the most self-control. Row 6 to 8, however, show that the performances increases of students with lower self-control were larger and statistically significant relative to students with the most self-control, especially for those with IE gap less than 0. For example, if students with the least self-control (i.e., IE gap lesser than -2) were assigned the frequent marking scheme, on average their class participation increased by about 17 percent, their class participation scores (iClicker scores) increased by about 11 percentage points, and their course grades increase by about 10 percentage points. These effects were statistically significant at 1 percent significance level. This is equivalent to a course grade increase from 0.44 standard-deviations below the class average to 0.19 standard-deviations above the class average, which is close to that of students with the most self-control. The effects also become smaller and the statistical significance is reduced for students with more self-control.

These results of the Quant class indicate that students with less self-control will perform worse than those with higher self-control when they are not assigned the frequent marking, but their performances can be largely increased to a level that is comparable to that of students with the most self-control if they were assigned the frequent marking. The Micro class has similar

[22]For the course grade, the Quant-class average of the regression sample is 68 and the standard deviation is 16.27.

results, but the differences in the treatment effects are not linear and mostly not statistically significant (as shown in Panel B of Table 15). These results are robust to the inclusion of other student attributes and to the linear specification.

In sum, comparing to earlier studies of self-control at work, this study did find the similar results that students with lower self-control abilities were helped the most if they were assigned the frequent marking scheme. Will this study also confirm the earlier findings that, on average, students with less self-control were aware of their problems and thus chose the more costly marking scheme to motivate their future selves? Next section will provide an answer to this question. The next section will investigate the characteristics of the students who prefer and do not prefer the frequent marking scheme, especially whether students who would benefit the most from the frequent marking will choose it when they are given the choice.

5 Who Preferred the Frequent Marking Scheme

Recall that, in step one of the experiment, students were asked to choose between two lotteries that differed in the chances of assigning the frequent and the infrequent marking scheme. The choices of lotteries reveal students' preferences for marking frequencies. Together with the data on individual attributes, this study explores the correlation between the preference for marking frequencies and individual attributes. Individual attributes collected include students' prior academic achievement (e.g., cumulative GPAs), demographics (e.g., gender, year of study, full or part time, first language), personalities (e.g., self-control ability, motivation, risk aversion) and personal difficulties in attending classes.

First, Panel A of Table 16 presents the results of regressing the indicator of the preference for frequent marking on students' prior academic achievement and other student characteristics in the Quant class. The first two columns, the third and fourth columns used cumulative GPA, average scores of prerequisite courses and whether a student failed course(s) before as measures of prior academic achievement, respectively. The results show that there was no statistically significant correlation between the preferences and students' prior academic achievements. Among other attributes, female students were about 7 percent more likely to prefer a frequent marking scheme[23] Students whose first language is French were about 23 percent more likely

[23]Female students have higher self-control ability but the relationship with risk aversion measures are contra-

to prefer the frequent marking than those whose first language is English, while those whose first language is not English or French were about 7 percent less likely to prefer the frequent marking. These results become statistically insignificant when Micro-class data is used, except that students whose first language is not English or French had same results as the Quant class (see Panel B of the table).

Second, my study also collected survey measures of personalities and individual difficulties in attending classes. Panel A of Table 17 shows the results of regressing the indicator of students' preferences for the frequent marking on the measures of self-control, motivation, risk aversion, as well as personal difficulties in attending classes using the Quant-class data. Since measures of individual differences are of different scales, these independent variables are thus standardized by sample means and standard deviations for easy comparison. The interpretation of the estimated coefficients of the standardized variables are thus in comparison to students with average values.

As for the motivation to succeed (i.e., IPIP motivation based on the existing psychology inventory of the International Personality Item Pool), there is not a statistically significant correlation between the preference and the measure of motivation. Students with higher motivation were not statistically significantly more likely to prefer the frequent marking than average students. As for students with lower motivation, they, however, were not more likely to seek help than average students.

Regarding students with different levels of risk aversion (measured by the survey of Holt and Laury (2002)), there is again no statistically significant difference in preference for marking frequencies by levels of risk aversion. Similar result holds when another measure of risk aversion (gathered from the general risk preference question[24]) is used.

Regarding the measure of self-control abilities, the results are contradictory to earlier studies. The self-control ability is measured by the IE gap based on the questionnaire of Ameriks, Caplin, Leahy and Tyler (2002). The larger is this number, the higher is the self-control ability. The coefficients of IE gap in different specifications are positive and statistically significant in column 1 to 3 of Panel A and B. That is, students whose self-control abilities were one standard deviation

dictory.

[24] A question of the general risk attitude asked students to rate their readiness to take risks. The higher is the number, the more is the risk-loving.

higher than the class average were about 4 and 9 percent more likely to prefer the frequent marking than average students in the Quant and Micro class, respectively. In other words, students with lower self-control were less likely to prefer the frequent marking. This contradicts with findings of the earlier studies of self-control at work or in study (e.g., Kaur, Kremer and Mullainathan, 2014; Webb, Christian and Armitage, 2007 and Ariely and Wertenbroch, 2002). Their studies found that people who have self-control problem are sophisticated enough to realize their problems and try to overcome it by self-imposing costly constraints. This study, however, finds that on average students lack self-control did not prefer the frequent marking scheme. They either did not realize their problems or they did not want to overcome them.[25]

Other significant differences in the preferences for frequent marking are of students with work commitment or long travel distance to school in the Quant class. Students who had work commitments as the major obstacle to attend classes were less likely to prefer the frequent marking (about 17 percent less likely to prefer the frequent marking) than those who had no major obstacles to attend classes. However, students with longer travel distance to school were more likely to choose the frequent marking. These results may be because that those students with work commitment were not able to attend class due to time conflict and thus preferred the infrequent marking. In contrast, students with longer travel distance may wish to motivate their future selves to attend classes by choosing the frequent marking. This can be supported by looking at the reasons of choices that students self-reported. Among students who had travel distance as major obstacle to attend classes and preferred the frequent marking, 60 percent of them preferred it for the reason that "class participation is important to me. Getting graded more often will encourage me to come to class and/or pay better attention".[26] However, This study do not find different effects of the frequent marking on performance of students with different levels of work commitments nor of students with different levels of travel distance to school. In the Micro class, work commitment also reduced students' probability of preferring frequent marking. In addition, students with family obligation as major obstacle to attend classes were also about 40 percent more likely to prefer frequent marking. All of these

[25]The result is insignificant by using another measure of self-control by the International Personality Item Pool.

[26]For those who lived far from school and provided reasons for their preferences, 63 students preferred frequent marking and 18 did not prefer it. Among those who preferred the frequent marking, 38 students preferred it because they want to self-commit to the frequent marking to motivate their future selves.

students stated that their reason of preferring frequent marking is because "class participation is important to me. Getting graded more often will encourage me to come to class and/or pay better attention".

In sum, there is no significant differences in the preference for frequent marking among students of different academic abilities (e.g., measured by cumulative GPAs), nor among students of different levels of motivation and risk aversion. Moreover, students who lack self-control were less likely to prefer the frequent marking scheme. These findings indicate that even though students with lower prior achievement and with less self-control would perform better if they were assigned the frequent marking, they did not choose the more helpful option when they were given the choice. Lastly, students with more work commitment were less likely to prefer the frequent marking probably due to time conflicts, while students with longer travel distance and family obligation were more likely to prefer the frequent marking scheme probably in order to motivate their future selves. These results are robust if we use probit regression by relaxing the linearity assumption.

6 Conclusions

There were two steps in the experiment design of this study. In step one, students were offered a choice between lotteries that differ in the probabilities of assigning students to the frequent and infrequent marking scheme for class participation. The choices of lotteries tell us the students' preferences for the marking frequencies. In step two, after students reveal their preferences for the marking frequencies, this study overruled some of them by randomly assigning students into the frequent or infrequent marking schemes. The randomization was successful and thus helps to establish the causal interpretation of the effects of the frequent marking on students' performance within each preference type. With survey measures of self-control, motivation, risk aversion, personal difficulties to attend lectures, along with the data of students' prior academic achievements and demographics, the study is able to explore the correlation between the preferences for marking frequencies. With this data, the study is also able to explore the heterogeneous effects of the frequent marking on student performances.

On average, in the two experiment classes, students who were assigned the frequent mark-

ing had 12 to 20 percent higher class participation, 1 to 3 percentage points higher class-participation grades, and 5 to 7 percentage points higher course grades than students who were not assigned the frequent marking.

More importantly, students who did not prefer the frequent marking than those who preferred it. Students with lower academic achievements or lower self-control abilities were helped the most by being assigned to the frequent marking scheme. In other words, their performance improvements are larger under the frequent than infrequent marking schemes compared to students with higher abilities. However, these students were not more likely to prefer the frequent marking than students with higher abilities. These results indicate that students who need help the most would have large improvement in performance if they are assigned the frequent marking for class participation. However, these students were not more likely to seek help even when they are given the choice. These results are robust by the different measures of self-controls and academic abilities, as well as inclusion of other controls.

I also want to elaborate on the finding that students with less self-control were less likely to choose the frequent marking when they are given the choice. Earlier studies of self-control at work or in study (Kaur, Kremer and Mullainathan, 2014; Webb, Christian, and Armitage, 2007; Ariely and Wertenbroch, 2002) suggest that sophisticated students realize their self-control problems (i.e., they do not work as hard as they would like) and try to control them by self-imposing costly constraints at work or in study. In my experiment design, this corresponds to students choosing the frequent marking scheme for class participation. However, this study did not find that students lacking self-control preferred the frequent marking scheme. This indicates that either students lacking self-control were not sophisticated enough to realize their problems, or they realized their problems but did not wish to overcome them. The result is thus not consistent with a self-control agency model. Earlier studies of self-control at work (Kaur, Kremer and Mullainathan, 2014) also find that self-imposed constraints at work or in study increased performance, especially for those who lack self-control. This study does find that students with lower self-control have a higher increase in performance if they are assigned the frequent marking than students with higher self-control.

In sum, the frequent marking scheme causally increased the preformances of students who do not want it more than that of students who want it. Students of lower academic achievements

and lower self-controls also benefited more than other students. When they are not assigned the frequent scheme, these students attend and participate in class much less frequently and obtain lower course grades than other students. Imposing frequent marking will help them greatly with reasonable costs and minimum burden to instructors by the use of classroom technologies, such as iClicker or REEF Polling. Currently, the average cost of the hand-held iClicker device to students is around 18 Canadian dollars considering that new and used devices can be purchased and resold to the campus bookstore. The administrative burden is also largely reduced since students' individual responses are recorded electronically and can be marked by the software. Of course, these estimated effects are short-term effects. For longer term effects, this study will need to follow up on these students' future performances, such as choices of majors, and academic performance. The external validity of this study to other disciplines or teaching styles would also require larger scale experiments across different disciplines and different teaching styles. The external validity of this study to dropouts also deserves separate study.

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7 Tables

	Panel A: Quant Class				Panel B: Micro Class			
Prefer Frequent Marking or Not?	Obs.	Percentage assigned	Mean difference in dropout rates	P-value	Obs.	Percentage assigned	Mean difference in dropout rates	P-value
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Do Not Prefer	163	48%	-0.08	0.2551	44	39%	0.17	0.2520
Prefer	427	65%	-0.09	0.0466	77	71%	0.09	0.1474
All	590	60%	-0.08	0.0181	121	59%	0.02	0.8072

Source: Author's tabulation of 2014 registrar office and survey data. Sample: students who consented for data collection. Assignment of Marking Scheme is at the third week of the class. Percentage assigned is the percentage of students who were assigned the frequent marking scheme. Mean difference in dropout rates = Dropout rates of those assigned the frequent marking – Dropout rates of those not assigned the frequent marking.

Table 1: Average Dropout Rates between Those Assigned and Not Assigned the Frequent Marking Scheme

Preference and Assignment Type	Obs	Dropout rate	CGPA		Female		Year of Study		Self-control (IE gap)		Motivation (IPIP)		Risk aversion (# of safe choices)	
			Mean difference	p-value	Mean difference	p-value	Mean difference	p-value	Mean difference	p-value	Mean difference	p-value	Mean difference	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Panel A: Quant Class													
Not Prefer, Not Assigned	85	28%	0.21	0.2115	0.02	0.8972	0.01	0.8423	-0.30	0.5018	-3.40	0.0724	-0.07	0.8824
Not Prefer, Assigned	78	21%	0.17	0.3774	0.01	0.9542	-0.11	0.3702	-1.03	0.1377	-1.56	0.2449	-0.49	0.4469
Prefer, Not Assigned	150	28%	0.08	0.5256	-0.03	0.7213	-0.03	0.6759	-0.61	0.0873	0.05	0.9681	-0.04	0.9295
Prefer, Assigned	277	19%	-0.11	0.2481	0.04	0.5857	-0.11	0.0424	-0.33	0.2587	-0.04	0.9551	-0.25	0.3806
Total	590	23%	0.03	0.6304	0.01	0.8482	-0.07	0.0639	-0.51	0.0115	-0.85	0.1478	-0.19	0.3486
	Panel B: Micro Class													
Not Prefer, Not Assigned	27	30%	0.29	0.3977	-0.03	0.9052	-0.08	0.7483	0.51	0.4579	0.48	0.7214	-0.64	0.5007
Not Prefer, Assigned	17	47%	-0.35	0.4216	0.39	0.0882	0.11	0.6099	-0.78	0.4343	2.54	0.2829	0.51	0.4234
Prefer, Not Assigned	22	0%												
Prefer, Assigned	55	9%	0.97	0.0105	0.34	0.1146	-0.44	0.0531	-1.52	0.0231	1.50	0.4597	0.60	0.6118
Total	121	17%	0.25	0.2103	0.15	0.1933	-0.10	0.4236	-0.70	0.0523	1.17	0.2275	0.05	0.9261

Source: Author's tabulation of 2014 registrar office and survey data. Sample: students who consented for data collection. Mean difference is the difference in means between non-dropouts and dropouts (i.e., Mean of non-dropouts – Mean of dropouts). P-value is the t-test result of testing the null hypothesis of zero mean difference against the alternative hypothesis of non-zero mean difference.

Table 2: Differences in Student Characteristics between Dropouts and Non-dropouts

Student Characteristics	Quant Class			Micro Class		
	Mean	Std Dev	Obs	Mean	Std Dev	Obs
	(1)	(2)	(3)	(4)	(5)	(6)
Proportion female	0.59	0.49	467	0.64	0.48	106
Age	19.37	1.53	467	19.70	1.60	106
Year of study	2.11	0.38	467	2.13	0.48	106
Proportion of full time	0.96	0.20	467	0.94	0.23	106
Proportion first language						
English	0.38	0.49	467	0.28	0.45	106
French	0.01	0.07	467	0.02	0.14	106
Other	0.61	0.49	467	0.70	0.46	106
Prerequisite average	74.48	9.29	466	73.75	8.85	102
CGPA	3.11	0.64	468	2.79	0.80	100
Failed course(s) before	0.17	0.38	479	0.18	0.39	106
Degree program of study						
BCOM	0.78	0.41	464	0	0	104
HBA	0.13	0.34	464	0.35	0.48	104
HBSC	0.08	0.28	464	0.63	0.48	104
Other	0.01	0.08	464	0.02	0.14	104
Father Education						
Less than HS	0.05	0.22	468	0.01	0.10	106
HS or equivalent (e.g., GED)	0.12	0.33	468	0.14	0..35	106
Some college but no degree	0.08	0.27	468	0.07	0.25	106
Associate degree (2 year undergraduate)	0.06	0.25	468	0.04	0.19	106
Bachelor degree (4 year undergraduate)	0.37	0.48	468	0.43	0.49	106
Graduate degree	0.32	0.47	468	0.31	0.47	106
Mother Education						
Less than HS	0.05	0.22	464	0.04	0.19	105
HS or equivalent (e.g., GED)	0.13	0.34	464	0.09	0.28	105
Some college but no degree	0.10	0.30	464	0.15	0.36	105
Associate degree (2 year undergraduate)	0.09	0.28	464	0.10	0.31	105
Bachelor degree (4 year undergraduate)	0.43	0.49	464	0.38	0.49	105
Graduate degree	0.20	0.39	464	0.24	0.43	105

Source: Author's tabulation of 2014 registrar office and survey data. Sample: students who did not drop out of the course.

Table 3: Summary Statistics of Student Attributes

Student Personalities and Personal Difficulties	Quant Class			Micro Class		
	Mean (1)	Std Dev (2)	Obs (3)	Mean (4)	Std Dev (5)	Obs (6)
Major obstacles for class attendance						
Work commitment	0.09	0.29	468	0.09	0.29	106
Family commitment	0.07	0.25	467	0.09	0.29	106
Social commitment	0.13	0.33	468	0.11	0.32	106
Travel distance to school	0.17	0.38	468	0.08	0.27	106
No major obstacle	0.68	0.47	468	0.71	0.46	106
No. of safe choices (Holt and Laury measure of risk averse)	5.33	1.97	464	5.56	2.23	106
General risk attitude	5.63	2.24	468	5.90	2.06	106
IE-gap (Ameriks, Caplin, Leahy and Tyler measure of self-control)	0.04	1.20	470	-0.11	1.21	106
IPIP self-control	2.84	5.51	495	3.5	6.99	120
Students agreed or strongly agreed with the statement:						
I get chores done right away.	0.45	0.50	466	0.43	0.50	106
I am always prepared.	0.58	0.49	466	0.47	0.50	106
I start tasks right away.	0.41	0.49	466	0.39	0.49	106
I get to work at once.	0.43	0.50	466	0.34	0.48	106
I carry out my plans.	0.72	0.45	466	0.60	0.49	106
I find it difficult to get down to work.	0.30	0.46	466	0.26	0.44	106
I waste my time.	0.41	0.49	466	0.42	0.50	106
I need a push to get started.	0.43	0.50	466	0.35	0.48	106
I have difficulty starting tasks.	0.28	0.45	466	0.25	0.44	106
I postpone decisions.	0.32	0.47	466	0.34	0.48	106
IPIP motivation	16.56	5.94	495	17.6	6.71	120
Students agreed or strongly agreed with the statement.						
I go straight for the goal.	0.71	0.45	466	0.61	0.49	106
I work hard.	0.73	0.45	466	0.67	0.47	106
I turn plans into actions.	0.72	0.45	466	0.68	0.47	106
I plunge into tasks with all my heart.	0.59	0.49	466	0.55	0.50	106
I do more than what's expected of me.	0.54	0.50	466	0.42	0.50	106
I set high standards for myself and others.	0.79	0.41	466	0.65	0.48	106
I demand quality.	0.85	0.36	466	0.75	0.43	106
I am highly motivated to succeed.	0.12	0.32	466	0.15	0.36	106
I do just enough work to get by.	0.18	0.38	466	0.25	0.44	106
I put little time and effort into my work.	0.07	0.26	466	0.17	0.38	106

Source: Author's tabulation of 2014 registrar office and survey data. Sample: students who did not drop out of the course.

Table 4: Summary Statistics of Survey Measures

Panel A: All Students (Quant Class)

Assignment of Marking Scheme	Percent	CGPA	Failed course(s) before	Year of Study	Female	Self-control (IE gap)	Motivation (IPIP)	Risk aversion (# of safe choices)
Infrequent marking	39%	3.11	0.17	2.10	0.61	0.15	17.09	5.27
Frequent marking	61%	3.11	0.15	2.11	0.58	-0.02	16.31	5.36
P-value		0.9935	0.6111	0.9031	0.4616	0.3905	0.1642	0.6029
Obs.	468	468	453	467	467	446	468	464

Panel B: All Students (Micro Class)

Assignment of Marking Scheme	Percent	CGPA	Failed course(s) before	Year of Study	Female	Self-control (IE gap)	Motivation (IPIP)	Risk aversion (# of safe choices)
Infrequent marking	41%	2.72	0.27	2.15	0.44	0.02	14.63	5.1
Frequent marking	59%	2.84	0.14	2.15	0.76	-0.24	16.36	5.81
P-value		0.4823	0.0981	0.9497	0.0008	0.2970	0.0361	0.1238
Obs.	100	100	100	100	100	100	100	99

Source: Author's tabulation of 2014 registrar office and survey data. Sample: students who did not drop out of the course and consented for data collection.

Table 5: Pre-treatment Characteristics of the Frequent and Infrequent Group

Panel A: Quant Class						
	Dependent Variables					
VARIABLES	Class participation rate	iClicker Score	Average test score	Final exam score	Course grade	Course grade (no iClicker)
	(1)	(2)	(3)	(4)	(5)	(6)
Assigned frequent	11.76***	2.974***	8.196***	10.28***	6.891***	6.336***
	(1.938)	(0.732)	(1.577)	(2.179)	(1.657)	(1.608)
Constant	72.86***	73.48***	53.39***	49.23***	63.80***	56.71***
	(1.696)	(0.626)	(1.380)	(1.860)	(1.474)	(1.426)
Observations	468	467	468	468	468	467
Adjusted R-squared	0.083	0.036	0.061	0.049	0.041	0.036
RMSE	18.90	7.267	15.39	21.68	15.93	15.46
Panel B: Micro Class						
	Dependent Variables					
VARIABLES	Class participation rate	iClicker Score	Average test score	Final exam score	Course grade	Course grade (no iClicker)
	(1)	(2)	(3)	(4)	(5)	(6)
Assigned frequent	20.16***	1.371	5.681*	8.093*	5.378*	5.282*
	(4.052)	(1.709)	(2.945)	(4.265)	(2.732)	(2.671)
Constant	63.31***	71.56***	49.56***	41.20***	54.33***	49.32***
	(3.515)	(1.273)	(2.295)	(3.383)	(2.141)	(2.101)
Observations	100	100	100	100	100	100
Adjusted R-squared	0.215	-0.004	0.027	0.027	0.029	0.029
RMSE	18.68	8.512	14.39	20.67	13.31	13.00

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 6: Average Effects of Frequent Marking on Performance

Panel A: Quant Class												
VARIABLES	Class participation rate		iClicker score		Average of test score		Final exam score		Course grade		Course grade (no iClicker score)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Assigned frequent	11.00***	11.38***	2.633***	2.711***	7.109***	7.613***	9.046***	9.670***	5.744***	6.234***	5.466***	5.674***
	(1.814)	(2.084)	(0.755)	(0.799)	(1.284)	(1.728)	(1.958)	(2.348)	(1.338)	(1.817)	(1.310)	(1.764)
Constant	51.02***	73.14***	70.94***	73.78***	34.65***	54.18***	25.62***	50.11***	41.12***	64.71***	34.14***	57.62***
	(7.144)	(1.841)	(3.470)	(0.695)	(5.938)	(1.540)	(9.473)	(2.048)	(6.793)	(1.644)	(6.741)	(1.594)
Observations	442	440	441	439	442	440	442	440	442	440	441	439
Adjusted R-squared	0.290	0.074	0.150	0.023	0.418	0.054	0.302	0.044	0.406	0.037	0.388	0.032
rmse	16.57	18.92	6.832	7.321	12.26	15.62	18.72	21.90	12.69	16.14	12.47	15.67
Student characteristics	YES		YES		YES		YES		YES		YES	
Personalities		YES		YES		YES		YES		YES		YES
Panel B: Micro Class												
VARIABLES	Class participation rate		iClicker score		Average of test score		Final exam score		Course grade		Course grade (no iClicker score)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Assigned frequent	15.13***	19.77***	1.309	0.960	5.134**	4.491	8.297**	7.719*	5.259**	4.772*	5.167**	4.705*
	(4.180)	(4.148)	(1.716)	(1.665)	(2.387)	(3.058)	(4.064)	(4.476)	(2.406)	(2.837)	(2.362)	(2.785)
Constant	41.90**	62.63***	83.10***	72.33***	49.04***	50.62***	48.08***	41.32***	57.70***	54.82***	51.89***	49.75***
	(16.55)	(3.652)	(4.777)	(1.413)	(8.322)	(2.712)	(11.39)	(3.945)	(7.479)	(2.515)	(7.313)	(2.470)
Observations	100	99	100	99	100	99	100	99	100	99	100	99
Adjusted R-squared	0.341	0.249	0.275	-0.010	0.420	0.040	0.323	0.011	0.394	0.021	0.384	0.022
rmse	17.13	18.34	7.235	8.529	11.11	14.35	17.24	20.90	10.52	13.40	10.36	13.09
Student characteristics	YES		YES		YES		YES		YES		YES	
Personalities		YES		YES		YES		YES		YES		YES

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; student characteristics controlled include cumulative GPAs, gender, year of study, full time indicator and personal difficulties in attending class; personalities controlled include self-control measure (IE gap), motivation (IPIP), and number of safe choices. All independent variables are standardized except for dummy variables.

Table 7: Average Effects of Frequent Marking (controls for student attributes)

	Quant Class	Micro Class
VARIABLES	Self-study time (weekly)	Self-study time (weekly)
Assigned frequent	-0.160	-0.0980
	(0.185)	(0.357)
Constant	2.806***	2.988***
	(0.148)	(0.274)
Observations	444	100
Adjusted R-squared	-0.001	-0.009
RMSE	1.868	1.756

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 8: Average Effects of Frequent Marking on Weekly Self-Study Time

Panel A: Students who Prefer Infrequent Marking (Quant Class)

Assignment of Marking Scheme	Percent	CGPA	Failed course(s) before	Year of Study	Female	Self-control (IE gap)	Motivation (IPIP)	Risk aversion (# of safe choices)
Infrequent marking	0.49	3.08	0.20	2.11	0.56	-0.07	17.22	5.30
Frequent marking	0.51	3.13	0.17	2.12	0.49	-0.52	16.30	5.15
P-value		0.6568	0.6634	0.8331	0.4286	0.2592	0.4345	0.7049
Obs.	130	130	127	129	129	123	130	119

Panel B: Students who Prefer Frequent Marking (Quant Class)

Assignment of Marking Scheme	Percent	CGPA	Failed course(s) before	Year of Study	Female	Self-control (IE gap)	Motivation (IPIP)	Risk aversion (# of safe choices)
Infrequent marking	0.35	3.13	0.16	2.10	0.64	0.27	17.02	5.20
Frequent marking	0.65	3.10	0.15	2.10	0.60	0.13	16.31	5.42
P-value		0.7622	0.8477	0.9481	0.5234	0.5445	0.2697	0.3408
Obs.	338	338	326	338	338	323	338	332

Panel C: Students who Prefer Infrequent Marking (Micro Class)

Assignment of Marking Scheme	Percent	CGPA	Failed course(s) before	Year of Study	Female	Self-control (IE gap)	Motivation (IPIP)	Risk aversion (# of safe choices)
Infrequent marking	0.68	2.85	0.21	2.21	0.47	0.26	15.11	5.11
Frequent marking	0.32	2.58	0.22	2.11	0.89	0.22	16.67	5.89
P-value		0.3930	0.9464	0.6147	0.0364	0.9247	0.3025	0.3730
Obs.	28	28	28	28	28	28	28	28

Panel D: Students who Prefer Frequent Marking (Micro Class)

Assignment of Marking Scheme	Percent	CGPA	Failed course(s) before	Year of Study	Female	Self-control (IE gap)	Motivation (IPIP)	Risk aversion (# of safe choices)
Infrequent marking	0.31	2.62	0.32	2.09	0.41	-0.18	14.23	5.10
Frequent marking	0.69	2.89	0.12	2.16	0.74	-0.32	16.3	5.8
P-value		0.2057	0.0447	0.5803	0.0066	0.6736	0.0542	0.2457
Obs.	72	72	72	72	72	72	72	71

Source: Author's tabulation of 2014 registrar office and survey data. Sample: students who did not drop out of the course and consented for data collection.

Table 9: Pre-treatment Characteristics of the Frequent and Infrequent Group by Preference Types

Panel A: Quant Class						
VARIABLES	Dependent Variables					
	Class participation rate	iClicker score	Average test score	Final exam score	Course grade	Course grade (no iClicker)
	(1)	(2)	(3)	(4)	(5)	(6)
Assigned frequent	19.60***	5.245***	13.92***	17.72***	14.60***	13.47***
	(3.689)	(1.465)	(2.591)	(3.608)	(2.700)	(2.608)
Prefer frequent	14.77***	4.389***	9.047***	10.69***	12.71***	11.66***
	(3.577)	(1.401)	(2.797)	(3.842)	(2.941)	(2.844)
Assign Freq X Prefer Freq	-12.51***	-3.621**	-8.864***	-11.34**	-12.02***	-11.05***
	(4.264)	(1.663)	(3.223)	(4.470)	(3.342)	(3.243)
Constant	63.28***	70.62***	47.52***	42.30***	55.55***	49.10***
	(3.051)	(1.237)	(2.233)	(3.112)	(2.364)	(2.271)
Observations	468	467	468	468	468	467
Adjusted R-squared	0.130	0.065	0.086	0.066	0.091	0.081
RMSE	18.40	7.160	15.18	21.49	15.51	15.10
Panel B: Micro Class						
VARIABLES	Dependent Variables					
	Class participation rate	iClicker score	Average test score	Final exam score	Course grade	Course grade (no iClicker)
	(1)	(2)	(3)	(4)	(5)	(6)
Assigned frequent	21.37***	-1.351	-1.825	-4.211	-2.436	-2.341
	(6.767)	(3.870)	(4.292)	(5.475)	(3.564)	(3.447)
Prefer frequent	6.828	1.634	-2.510	-7.483	-3.783	-3.897
	(7.005)	(2.543)	(4.529)	(6.599)	(4.186)	(4.105)
Assign Freq X Prefer Freq	-3.930	2.613	9.777	17.26**	10.61**	10.42**
	(8.670)	(4.447)	(5.958)	(8.114)	(5.266)	(5.121)
Constant	59.65***	70.68***	50.91***	45.21***	56.36***	51.41***
	(4.975)	(1.752)	(2.787)	(4.065)	(2.495)	(2.460)
Observations	100	100	100	100	100	100
Adjusted R-squared	0.212	-0.001	0.030	0.037	0.037	0.038
RMSE	18.73	8.499	14.37	20.55	13.26	12.94

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 10: Effects of Frequent Marking by Preference Types

Student Performance	Quant Class			Micro Class		
	Mean	Std Dev	Obs	Mean	Std Dev	Obs
	(1)	(2)	(3)	(4)	(5)	(6)
Class participation rate	80.53	20.25	468	75.21	21.09	100
iClicker score (Class participation score)	75.30	7.40	467	72.37	8.50	100
Average test score	58.40	15.88	468	52.91	14.59	100
Final exam score	55.52	22.23	468	45.97	20.95	100
Course grade	68.01	16.27	468	57.50	13.51	100
Course grade (no iClicker score)	60.59	15.75	467	52.44	13.19	100

Source: Author's tabulation of 2014 registrar office and survey data. Sample: students who consented and did not drop out of the course.

Table 11: Average Course Performances

Assignment of Marking Scheme	Percent	CGPA	Failed course(s) before	Year of Study	Female	Self-control (IE gap)	Motivation (IPIP)	Risk aversion (# of safe choices)
Panel A: Quant Class								
CGPAs below 2.5								
Infrequent marking	40%	2.17	0.38	2.28	0.56	0.03	15.69	5.28
Frequent marking	60%	2.03	0.37	2.13	0.55	0.21	16.48	5.23
P-value		0.1517	0.9113	0.1556	0.9387	0.6745	0.4951	0.9036
Obs.	90	90	88	89	89	85	90	85
CGPAs between 2.5 and 3								
Infrequent marking	41%	2.83	0.19	2.02	0.66	-0.14	18.16	5.40
Frequent marking	59%	2.86	0.19	2.06	0.62	-0.05	16.17	5.10
P-value		0.3081	0.9580	0.4732	0.6754	0.8347	0.1237	0.4866
Obs.	107	107	99	107	107	98	107	96
CGPAs between 3 and 3.5								
Infrequent marking	38%	3.33	0.02	2.06	0.56	-0.12	17.82	5.17
Frequent marking	62%	3.31	0.06	2.13	0.53	-0.26	16.59	5.58
P-value		0.4287	0.2941	0.3032	0.6996	0.6802	0.2437	0.2507
Obs.	130	130	127	130	130	123	130	120
CGPAs above 3.5								
Infrequent marking	37%	3.79	0.16	2.10	0.65	0.64	16.44	5.14
Frequent marking	63%	3.75	0.08	2.11	0.61	0.08	16.04	5.38
P-value		0.1560	0.1400	0.8133	0.5806	0.1309	0.6976	0.4871
Obs.	141	141	139	141	141	140	141	139
Panel B: Micro Class								
CGPAs below 2.5								
Infrequent marking	44%	1.87	0.56	2.06	0.44	0.31	13.50	4.67
Frequent marking	56%	1.94	0.30	2.15	0.70	0.15	16.05	5.75
P-value		0.6521	0.1189	0.6246	0.1189	0.6796	0.1201	0.2056
Obs.	36	36	36	36	36	36	36	35
CGPAs between 2.5 and 3								
Infrequent marking	47%	2.88	0.13	2.25	0.38	-0.63	13.88	4.5
Frequent marking	63%	2.77	0.00	2.14	0.86	-0.50	14.57	6.5
P-value		0.1048	0.1926	0.5533	0.0184	0.8386	0.6142	0.0349
Obs.	22	22	22	22	22	22	22	22
CGPAs between 3 and 3.5								
Infrequent marking	50%	3.29	0.09	2.09	0.45	-0.18	16.18	5.64
Frequent marking	50%	3.30	0.09	2.27	0.73	-0.27	17.73	5.00
P-value		0.8281	1.0000	0.4080	0.2114	0.8403	0.3136	0.5048
Obs.	22	22	22	22	22	22	22	22
CGPAs above 3.5								
Infrequent marking	30%	3.77	0.00	2.33	0.50	0.50	15.83	6.00
Frequent marking	70%	3.83	0.07	2.07	0.79	-0.50	17.50	5.86
P-value		0.2896	0.5274	0.2845	0.2220	0.1358	0.3241	0.8948
Obs.	20	20	20	20	20	20	20	20

Source: Author's tabulation of 2014 registrar office and survey data. Sample: students who did not drop out of the course and consented for data collection.

Table 12: Pre-treatment Characteristics by levels of Cumulative GPAs

Panel A: Quant Class						
	Dependent Variables					
VARIABLES	Class participation rate	iClicker score	Average test score	Final exam score	Course grade	Course grade (no iClicker)
	(1)	(2)	(3)	(4)	(5)	(6)
Assigned frequent	0.795	0.800	-3.050	-1.161	-3.996*	-4.076*
	(2.760)	(1.201)	(2.103)	(3.008)	(2.158)	(2.081)
CGPA below 2.5	-30.11***	-8.701***	-35.16***	-39.43***	-35.39***	-33.70***
	(4.525)	(1.666)	(2.424)	(4.167)	(2.912)	(2.797)
CGPA between 2.5 & 3	-20.38***	-7.070***	-27.55***	-32.80***	-28.05***	-27.34***
	(4.116)	(1.702)	(2.887)	(4.109)	(3.207)	(3.126)
CGPA between 3 & 3.5	-5.985*	-2.655**	-13.64***	-14.64***	-13.42***	-13.15***
	(3.280)	(1.305)	(2.468)	(3.558)	(2.624)	(2.560)
Assign Freq X CGPA below 2.5	19.67***	4.600**	21.69***	24.10***	22.10***	20.82***
	(5.413)	(2.016)	(3.328)	(5.326)	(3.519)	(3.405)
Assign Freq X CGPA between 2.5 & 3	17.70***	4.448**	15.69***	17.84***	14.30***	13.85***
	(4.912)	(1.996)	(3.445)	(5.035)	(3.745)	(3.653)
Assign Freq X CGPA between 3 & 3.5	9.555**	0.477	10.20***	7.083	9.696***	9.648***
	(3.878)	(1.655)	(3.028)	(4.561)	(3.164)	(3.086)
Constant	85.38***	77.62***	70.75***	68.98***	81.26***	73.50***
	(2.168)	(0.905)	(1.622)	(2.186)	(1.718)	(1.658)
Observations	468	467	468	468	468	467
Adjusted R-squared	0.243	0.132	0.405	0.277	0.384	0.375
Panel B: Micro Class						
	Dependent Variables					
VARIABLES	Class participation rate	iClicker score	Average test score	Final exam score	Course grade	Course grade (no iClicker)
	(1)	(2)	(3)	(4)	(5)	(6)
Assigned frequent	30.16***	3.286	2.940	6.643	3.946	3.716
	(9.182)	(4.652)	(5.917)	(7.829)	(5.329)	(5.051)
CGPA below 2.5	-1.389	-8.500*	-26.10***	-30.12***	-22.04***	-21.45***
	(10.88)	(4.649)	(6.025)	(7.624)	(5.283)	(5.022)
CGPA between 2.5 & 3	0.174	-7.500	-10.29	-14.12	-9.880	-9.355
	(13.05)	(4.816)	(6.626)	(10.03)	(6.361)	(6.127)
CGPA between 3 & 3.5	7.513	-4.318	-15.04**	-16	-12.12*	-11.82*
	(10.77)	(4.634)	(6.752)	(9.874)	(6.321)	(6.102)
Assign Freq X CGPA below 2.5	-17.24	-4.436	-0.328	-2.318	-1.356	-1.045
	(11.95)	(5.465)	(6.954)	(9.734)	(6.413)	(6.153)
Assign Freq X CGPA between 2.5 & 3	-6.126	-1.786	-0.369	-3.518	-1.665	-1.540
	(13.28)	(5.441)	(7.333)	(11.32)	(7.070)	(6.820)
Assign Freq X CGPA between 3 & 3.5	-11.60	-2.468	4.310	4.357	3.122	3.294
	(11.14)	(5.330)	(7.953)	(11.61)	(7.340)	(7.117)
Constant	61.81***	77.50***	65.79***	60***	68.11***	62.69***
	(9.125)	(4.190)	(5.426)	(6.562)	(4.701)	(4.425)
Observations	100	100	100	100	100	100
Adjusted R-squared	0.260	0.200	0.451	0.299	0.388	0.381

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 13: Treatment Effects by levels of Cumulative GPA

Panel A: Quant Class						
	Dependent variables					
VARIABLES	Class participation rate	iClicker score	Average test score	Final exam score	Course grade	Course grade (no iClicker)
	(1)	(2)	(3)	(4)	(5)	(6)
Assigned frequent	11.81***	3.047***	8.257***	10.36***	6.954***	6.623***
	(1.706)	(0.686)	(1.170)	(1.794)	(1.254)	(1.237)
CGPA (standardized)	12.25***	3.523***	13.76***	16.23***	14.17***	13.74***
	(1.581)	(0.608)	(1.030)	(1.481)	(1.075)	(1.107)
Assign Freq X CGPA (standardized)	-7.768***	-2.021***	-7.724***	-9.460***	-8.252***	-7.970***
	(1.923)	(0.716)	(1.252)	(1.863)	(1.263)	(1.283)
Constant	72.81***	73.41***	53.34***	49.17***	63.75***	56.43***
	(1.450)	(0.577)	(0.956)	(1.446)	(1.060)	(1.047)
Observations	468	467	468	468	468	467
Adjusted R-squared	0.255	0.139	0.429	0.303	0.404	0.388
RMSE	17.03	6.870	12.00	18.57	12.56	12.33
Panel B: Micro Class						
	Dependent variables					
VARIABLES	Class participation rate	iClicker score	Average test score	Final exam score	Course grade	Course grade (no iClicker)
	(1)	(2)	(3)	(4)	(5)	(6)
Assigned frequent	19.41***	0.887	4.528*	6.764*	4.398*	4.336*
	(3.936)	(1.555)	(2.423)	(3.848)	(2.346)	(2.307)
CGPA (standardized)	3.714	2.605*	8.063***	9.012***	6.690***	6.507***
	(3.655)	(1.346)	(1.818)	(2.712)	(1.694)	(1.654)
Assign Freq X CGPA (standardized)	4.571	2.426	1.214	2.094	1.445	1.275
	(4.326)	(1.785)	(2.286)	(3.651)	(2.238)	(2.190)
Constant	63.61***	71.77***	50.20***	41.91***	54.86***	49.84***
	(3.489)	(1.224)	(1.953)	(3.137)	(1.904)	(1.873)
Observations	100	100	100	100	100	100
Adjusted R-squared	0.304	0.225	0.380	0.253	0.330	0.321
RMSE	17.59	7.481	11.49	18.10	11.06	10.87

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; CGPA is standardized by sample means and standard deviations.

Table 14: Treatment Effects by levels of Continuous Cumulative GPA

Panel A: Quant Class						
VARIABLES	Dependent Variables					
	Class participation rate	iClicker score	Average test score	Final exam score	Course grade	Course grade (no iClicker)
	(1)	(2)	(3)	(4)	(5)	(6)
Assigned frequent	-0.240	-2.065	1.039	1.571	-1.963	-1.756
	(3.847)	(1.616)	(3.560)	(4.823)	(3.318)	(3.244)
IE gap below -2	-15.44***	-9.940***	-13.70***	-15.29***	-12.02***	-11.02***
	(5.577)	(2.562)	(3.957)	(5.604)	(4.077)	(3.967)
IE gap between -2 & -1	-12.71**	-3.103	-9.977*	-16.09**	-10.73*	-8.687
	(6.135)	(1.949)	(5.374)	(6.799)	(5.804)	(5.613)
IE gap at 0	-15.07***	-3.363**	-9.532**	-9.828*	-11.88***	-11.55***
	(4.276)	(1.535)	(3.922)	(5.404)	(4.009)	(3.923)
IE gap between 1 & 2	-11.15**	-2.065	-4.939	-6.640	-5.552	-5.346
	(5.342)	(1.693)	(4.184)	(5.853)	(4.171)	(4.067)
Assign Freq X IE gap below -2	16.81***	12.99***	13.07***	13.68**	12.26**	10.96**
	(6.414)	(2.930)	(4.844)	(6.878)	(4.898)	(4.777)
Assign Freq X IE gap between -2 & -1	17.38**	4.448*	11.78*	21.04***	12.60**	10.42*
	(7.119)	(2.517)	(6.142)	(7.840)	(6.407)	(6.204)
Assign Freq X IE gap at 0	15.47***	4.580**	7.286	7.324	11.19**	10.73**
	(5.269)	(2.079)	(4.716)	(6.456)	(4.690)	(4.588)
Assign Freq X IE gap between 1 & 2	9.783	3.358	2.483	3.717	4.605	4.269
	(6.318)	(2.223)	(5.123)	(7.045)	(4.971)	(4.847)
Constant	84.19***	77.06***	61.74***	59.16***	72.87***	65.17***
	(2.873)	(1.061)	(2.727)	(3.833)	(2.605)	(2.552)
Observations	446	445	446	446	446	445
Adjusted R-squared	0.097	0.084	0.066	0.054	0.047	0.041
Panel B: Micro Class						
VARIABLES	Dependent Variables					
	Class participation rate	iClicker score	Average test score	Final exam score	Course grade	Course grade (no iClicker)
	(1)	(2)	(3)	(4)	(5)	(6)
Assigned frequent	17.50	1.600	-1.350	-13.60	-5.814	-5.926
	(11.41)	(3.459)	(7.773)	(10.90)	(7.288)	(7.118)
IE gap below -2	25***	0.667	1.417	-18	-6.643	-6.690
	(5.478)	(1.434)	(7.228)	(18.14)	(9.493)	(9.593)
IE gap between -2 & -1	-3.125	-1.875	-7.094	-20**	-10.68**	-10.55*
	(7.477)	(2.871)	(5.464)	(8.692)	(5.371)	(5.359)
IE gap at 0	-0.260	-1.687	-6.281**	-21.44***	-10.95***	-10.84***
	(4.809)	(2.402)	(2.998)	(5.174)	(3.083)	(2.992)
IE gap between 1 & 2	-0.962	1.692	-1.442	-16.46***	-6.985	-7.104*
	(7.954)	(2.213)	(5.204)	(5.801)	(4.241)	(4.128)
Assign Freq X IE gap below -2	-17.92	-3.267	2.283	19.90	8.553	8.782
	(12.80)	(4.134)	(10.91)	(21.65)	(12.25)	(12.22)
Assign Freq X IE gap between -2 & -1	10.63	0.366	4.648	14.87	7.648	7.622
	(14.05)	(5.368)	(10.30)	(15.45)	(9.918)	(9.756)
Assign Freq X IE gap at 0	2.457	1.087	10.13	25.58**	13.96	13.88*
	(12.92)	(4.743)	(8.989)	(12.74)	(8.419)	(8.205)
Assign Freq X IE gap between 1 & 2	1.265	-0.201	8.065	27.06*	13.71	13.73
	(14.84)	(4.897)	(10.49)	(14.08)	(9.490)	(9.243)
Constant	62.50***	72***	53.75***	60***	63.39***	58.35***
	(3.30e-06)	(7.54e-07)	(2.48e-06)	(3.63e-06)	(2.21e-06)	(3.35e-06)
Observations	100	100	100	100	100	100
Adjusted R-squared	0.207	-0.062	-0.013	-0.009	-0.009	-0.008

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 15: Treatment Effects by Self-control Ability

Panel A: Quant Class				
	Dependent variable: indicator of preferring frequent marking			
VARIABLES	(1)	(2)	(3)	(4)
CGPA (standardized)	0.00247	-0.00214		
	(0.0207)	(0.0208)		
Prerequisite Average (standardized)			-0.00559	
			(0.0219)	
Failed course(s) before				-0.0334
				(0.0619)
Female		0.0732*	0.0773*	0.0718*
		(0.0432)	(0.0436)	(0.0434)
Year of study		-0.0228	-0.0174	-0.0185
		(0.0538)	(0.0548)	(0.0541)
Full Time Indicator		0.0710	0.0868	0.0619
		(0.0849)	(0.0882)	(0.0888)
French		0.234***	0.232***	0.228***
		(0.0522)	(0.0493)	(0.0508)
Other language		-0.0721*	-0.0764*	-0.0733*
		(0.0428)	(0.0428)	(0.0425)
Constant	0.722***	0.715***	0.686***	0.721***
	(0.0207)	(0.143)	(0.147)	(0.145)
Observations	468	444	441	444
Adjusted R-squared	-0.002	0.001	0.002	0.002
RMSE	0.449	0.443	0.444	0.443
Panel B: Micro Class				
	Dependent variable: indicator of preferring frequent marking			
VARIABLES	(1)	(2)	(3)	(4)
CGPA (standardized)	0.0104	-0.0323		
	(0.0438)	(0.0483)		
Prerequisite Average (standardized)			0.0424	
			(0.0407)	
Failed course(s) before				0.0184
				(0.119)
Female		0.00938	0.0209	0.0440
		(0.0944)	(0.0955)	(0.0933)
Year of study		-0.0346	-0.0782	-0.0699
		(0.0750)	(0.0838)	(0.0760)
Full Time Indicator		0.299	0.0765	0.166
		(0.192)	(0.165)	(0.146)
French		-0.339	-0.296	-0.295
		(0.383)	(0.379)	(0.380)
Other language		-0.198**	-0.197**	-0.202**
		(0.0919)	(0.0964)	(0.0920)
Constant	0.720***	0.658**	0.955***	0.839***
	(0.0453)	(0.298)	(0.291)	(0.258)
Observations	100	100	102	106
Adjusted R-squared	-0.010	0.024	0.002	0.014
RMSE	0.453	0.446	0.448	0.449

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; CGPAs and averages of prerequisite courses are standardized by sample means and standard deviations.

Table 16: Preference for Frequent Marking and Student Characteristics

Panel A: Quant Class			
	Dependent variable: preferring frequent marking		
VARIABLES	(1)	(2)	(3)
Self-control (standardized)	0.0482**	0.0433*	0.0405*
	(0.0223)	(0.0224)	(0.0226)
Motivation (standardized)		0.0182	0.0229
		(0.0273)	(0.0270)
Safe Choices (standardized)		0.0105	0.0122
		(0.0219)	(0.0218)
Work commitment			-0.178**
			(0.0823)
Family obligation			0.0240
			(0.0858)
Travel distance to school			0.0848*
			(0.0502)
Social activities			0.0691
			(0.0589)
Constant	0.724***	0.731***	0.724***
	(0.0211)	(0.0213)	(0.0261)
Observations	446	440	439
Adjusted R-squared	0.009	0.004	0.016
RMSE	0.445	0.444	0.442
Panel B: Micro Class			
	Dependent variable: preferring frequent marking		
VARIABLES	(1)	(2)	(3)
Self-control (standardized)	0.0865**	0.0865**	0.0955**
	(0.0374)	(0.0399)	(0.0391)
Motivation (standardized)		-0.0110	0.00824
		(0.0735)	(0.0736)
Safe Choices (standardized)		0.0139	0.0167
		(0.0449)	(0.0462)
Work commitment			-0.333**
			(0.146)
Family obligation			0.397***
			(0.0760)
Travel distance to school			-0.157
			(0.168)
Social activities			-0.199
			(0.139)
Constant	0.719***	0.713***	0.744***
	(0.0446)	(0.0492)	(0.0532)
Observations	100	99	99
Adjusted R-squared	0.028	0.009	0.090
RMSE	0.445	0.451	0.432

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; measures of personalities are standardized by sample means and standard deviations.

Table 17: Preference for Frequent Marking and Survey Measures

Figures

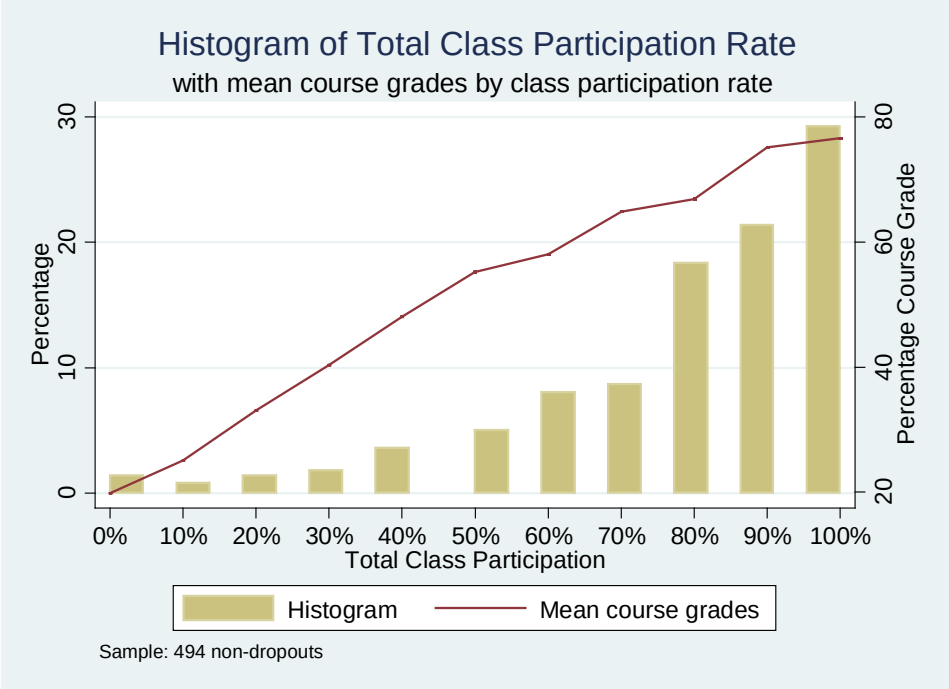

Figure 1: Histograms of Class Participation Rate and Mean Course Grade

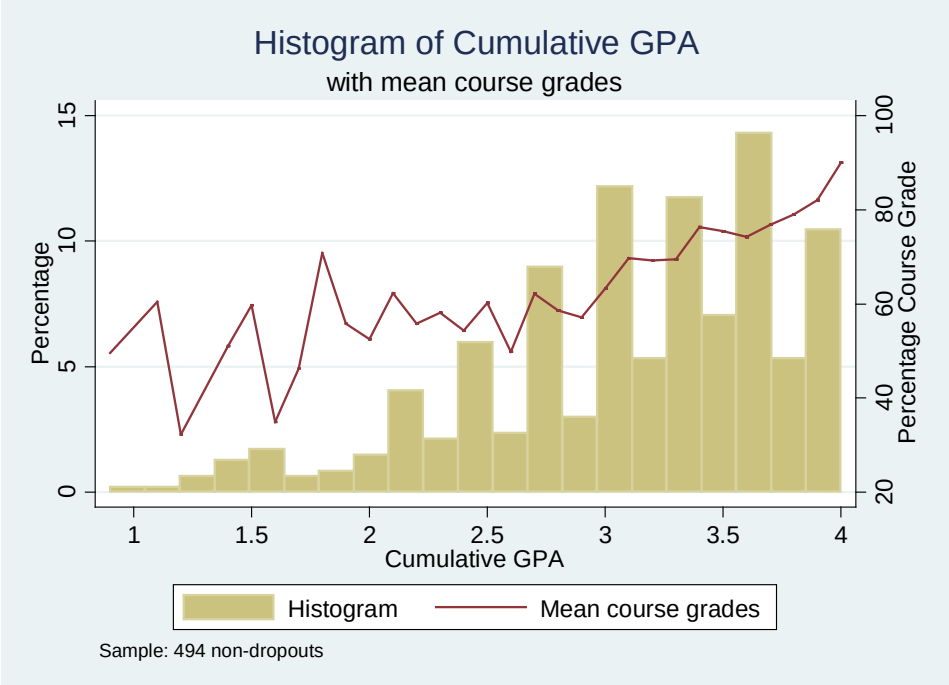

Figure 2: Histograms of CGPA and Mean Course Grade

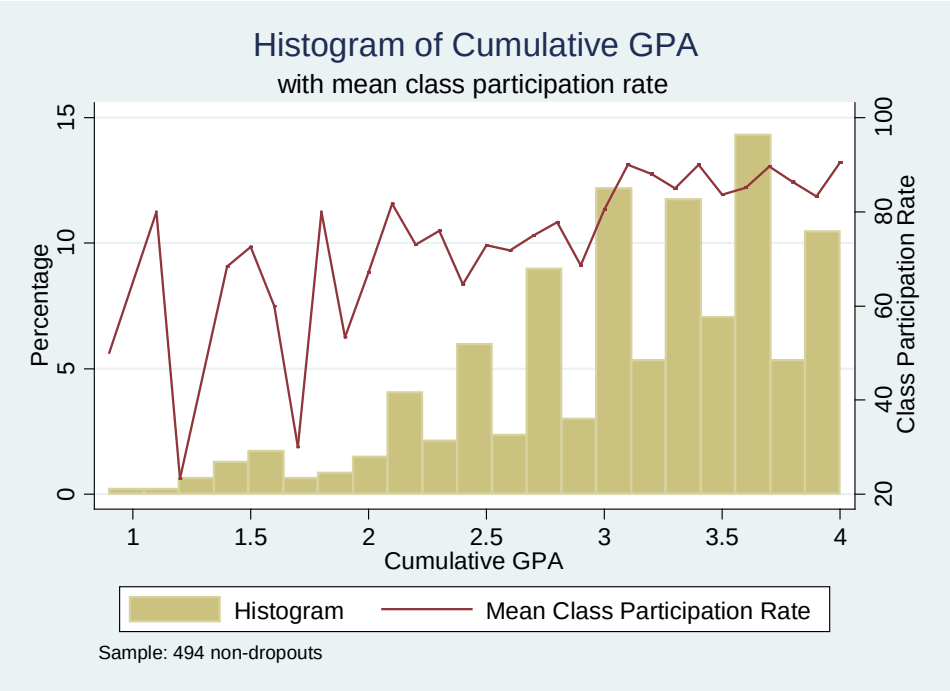

Figure 3: Histograms of CGPA and Mean Class Participation Rate

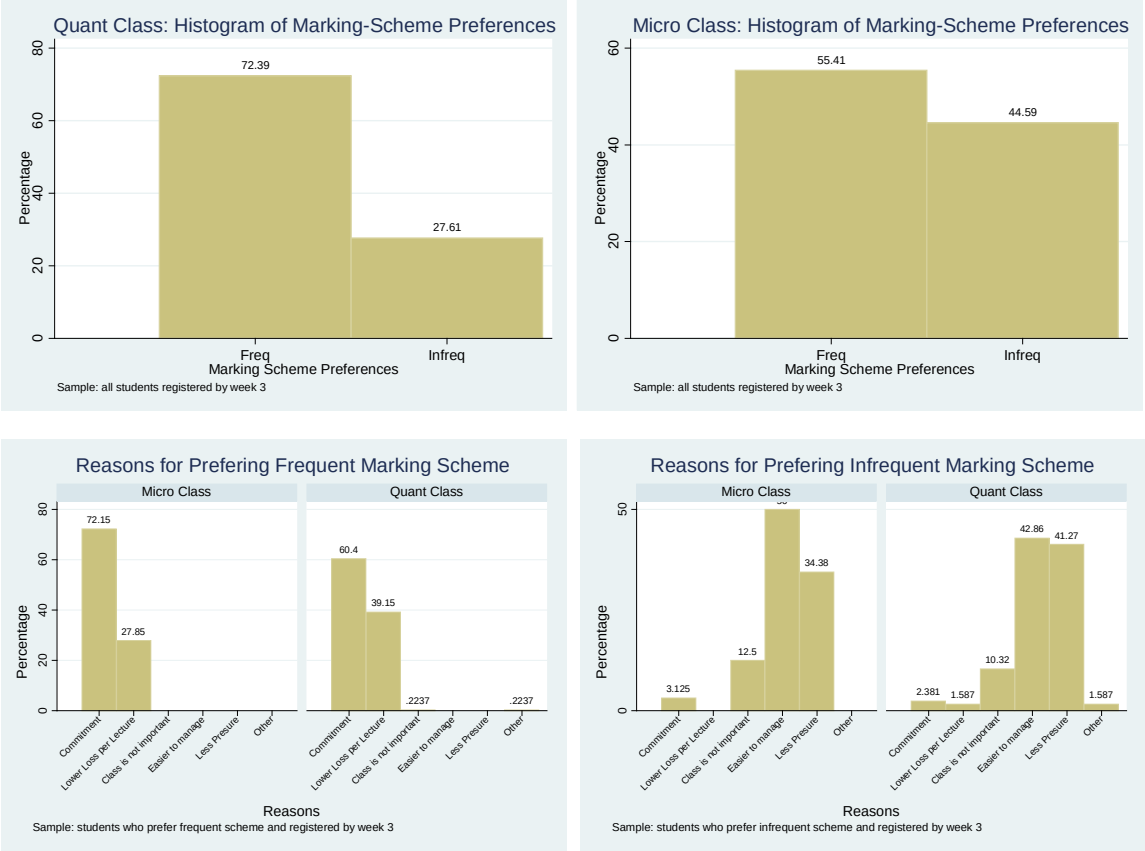

Figure 4: Histograms: Preferences and Reasons