STUDENT VIEWS ON THE USE OF A FLIPPED CLASSROOM APPROACH: EVIDENCE FROM AUSTRALIA

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ABSTRACT

A report on an introduction of a "flipped classroom" approach to lectures in a final-year actuarial course is presented. At the heart of the flipped classroom is moving the "delivery" of material outside of formal class time and using formal class time for students to undertake collaborative and interactive activities relevant to that material. Students were surveyed both at the start and end of the semester to obtain their views on lectures in general and the flipped classroom structure. After experiencing the entire course with this teaching style, student views became, on average, far more positive towards the flipped classroom approach.

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KEYWORDS: Flipped Classroom, Inverted Classroom, Student Perceptions

INTRODUCTION

The face-to-face model of a number of lectures plus a single tutorial each week has been a standard approach to course delivery in higher education for decades. Despite the revolution that the internet has been to education in providing flexible access to course material, tradition dictates that a number of hours each week be set aside for formal lectures and tutorials.

The maintenance of the formal lecture and tutorial structure is despite significant evidence that the traditional lecture format is not the most effective way for most students to learn. One approach to a more active student experience is through a "flipped classroom" model (first introduced by Baker, 2000, and Lage et al., 2000, and popularized through online videos and activities by, among others, Karl Fisch, Jon Bergmann and the Khan Academy). At the heart of the flipped classroom is moving the "delivery" of material outside of formal class time (through the use of extensive notes, video recorded lectures and other appropriate means) and using formal class time for students to undertake collaborative and interactive activities relevant to that material.

This paper reports on a move to a flipped classroom approach in a compulsory final-year course in the undergraduate actuarial program at the Australian National University (ANU). There are two specific research questions of interest. First, do students value the traditional lecture format compared to other learning activities? This is a question that has been extensively researched in the literature, although in this case it will flow into a second and less well researched question, how do students' perceptions of the use of class time change after being involved in a flipped classroom structure? Both of these questions are answered through the use of a two-part survey taken of students in July and October of the 2012 edition of the course, which was the first time the flipped classroom approach had been used in the course.

The next section of the paper reviews relevant literature, in particular that on the use of the flipped classroom approach. Following that is a data and methodology section outlining the flipped classroom approach undertaken and the survey methodology used in answering the two research questions. Following that is the results of the analysis and then concluding comments.

LITERATURE REVIEW

Prince (2004) provides an overview of the literature on "active learning" and notes the difficulty in measuring its effectiveness due to the different definitions of and approaches to active learning across the literature. In its broadest sense, Prince (2004) describes active learning as requiring students "to do meaningful learning activities and think about what they are doing". These learning environments are "student-centred" in that it is through student activity with the guidance of the teacher that learning occurs. In general, Prince (2004) presents significant evidence of the benefits of active learning. There has been a wealth of research into student perceptions of didactic compared to active learning environments, in both discipline-specific and general higher education literature. In addition to the benefits of active learning described by Prince (2004), Baeten et al. (2010) find that student-centred learning approaches are more likely (among other factors) to lead to a deep approach to learning (Marton and Säljö, 1976) by students.

Looking at examples within the discipline-specific literature, Butler (1992) finds that medical students perceive the didactic lecture to be the least effective learning tool within lecture time compared to more interactive approaches. Michael (2006) provides a meta-analysis of active learning in relation to teaching physiology and finds a variety of evidence of its success, although without finding one definitive type of experiment being used to prove the success. Armbruster et al. (2009) investigate the perception and performance of students in an introductory biology course where active learning was introduced through students being required to solve problems in groups in class, and find that student engagement and assessment performance is significantly improved compared to previous versions of the course. Garfield (1995) reviews prior literature on learning statistics and finds the key determinants in improved student performance are active participation in activities (including in a small group setting) and feedback on performance in these activities. Sander et al. (2000) note that first-year students in medical, business and psychology disciplines expect to be taught by formal and interactive lectures but prefer interaction and group-based activities. Smith (1998) finds student performance in and perception of first-year statistics is greatly improved by "doing statistics" in the course.

These previous studies are part of a very large body of literature looking at the effects of active teaching methods in higher education; no attempt is made here to provide a comprehensive overview beyond what is described above.

Biggs and Tang (2007) argue that courses should be "constructively aligned". In courses that are constructively aligned the desired learning outcomes are expressed in terms of the activities students are required to be able to demonstrate, with teaching and learning activities and assessment (both formative and summative) being designed to be consistent with these desired learning outcomes. Consistent with the student-centred approach to learning, Biggs and Tang (2007) argue that the most important aspect of a course is what the student does and not what the teacher does.

A "flipped classroom" approach (Baker, 2000), also known as an "inverted classroom" (Lage et al., 2000), is one approach that can be used to focus teaching activity on what the student actively does. The approach does this very explicitly, by bringing active student engagement with the material (such as problem-solving, case studies, etc., usually in collaboration with other students) directly into the classroom whilst moving more passive activities (such as reading course notes and textbooks and viewing/listening to lectures) outside of the classroom. Conversely, under a traditional didactic lecture structure this active student engagement is left to a single one hour tutorial each week, and then outside the classroom to individual study and/or informal study groups. To students, the syllabus and teaching material in a flipped classroom may not look particularly different to more traditional approaches, but the form of accessing the syllabus and teaching material is different. As such, a flipped classroom could be

seen as a stepping stone to less structured and inquiry-based learning environments such as problem-based learning (see Barrows, 1986, and Hmelo-Silver, 2004).

Academic research into student perceptions and the effectiveness of a flipped classroom is relatively limited at present, with the majority of commentary coming in the form of informal weblogs and the like. Bishop and Verleger (2013) provide a recent survey of research into the flipped classroom approach and report on eleven studies that have investigated student perceptions of the flipped classroom, with results being relatively consistent in that general student opinion of the flipped classroom tends to be positive, with a significant minority being opposed. Lage et al. (2000), in introducing the term "inverted classroom", find favorable impressions from students to the introduction of such a model in an introductory microeconomics course. Gannod et al. (2008) find that students in a software engineering course were largely happy with the model, although there were students who were not so supportive. Bates and Galloway (2012) find that 80% of survey respondents in a first-year physics course preferred the flipped structure to a traditional approach. Schullery et al. (2011) find a largely positive response from students in a flipped introductory business course, although 32% of survey respondents advocate a return to a traditional lecture format. Conversely, Strayer (2012) finds that students in a flipped classroom introductory statistics class were less satisfied with classroom structure than those in a traditional class, but that they became more open to co-operation and innovation as the semester progressed. Jaster (2013) finds a majority of students prefer a traditional lecture approach to a flipped classroom in a first-year algebra course.

DATA AND METHODOLOGY

Australian National University (ANU) is one of only six Australian universities to offer a program accredited by the Actuaries Institute. The Bachelor of Actuarial Studies is a three-year undergraduate program which provides students with the opportunity to meet the initial component of the qualification requirements of the Actuaries Institute. Accreditation requirements mean the syllabi for many of the courses within the program are heavily prescribed with technical content. Teaching time arrangements tend also to be fairly standard, with typically three hours of lectures and a one-hour tutorial allocated for each course.

Actuarial Techniques is a final-year course typically taken by undergraduate students in their final semester at ANU. A small number of postgraduate students take the course as well. It has approximately 100 enrolments. The syllabus for Actuarial Techniques is not as heavily prescribed as in other courses in the program, and hence the course has space to give students an exposure to actuarial problems in more of a business context, using Microsoft Excel where appropriate. Performing activities without Excel helps students to understand the underlying mathematical processes they are analyzing, while performing activities with Excel gives students a real-world perspective in addition to allowing for more complex processes to be modelled.

The flipped classroom approach used in this study was undertaken in Semester 2 (July – November), 2012. A collection of high-quality notes from previous iterations of the course was already in existence. These had in the past been used as a supplement to formal lectures; i.e. the lecturer would talk through the notes and expand and/or embellish on the notes as appropriate. The notes also included some worked examples of the concepts that were being outlined, which the lecturer would also go through during lectures.

Teaching time arrangements for the flipped classroom were maintained as being three hours of lectures (which will now be called "class" to distinguish it from a didactic lecture) and a one-hour tutorial. The first change made to the course material was to convert these notes into readings that students were expected to read before the relevant class. This involved expanding the notes to ensure they were

sufficiently detailed to stand alone without the need for lecturer embellishment and that the solutions to the examples in the notes were sufficiently detailed for students to follow. The aim of this exercise was to free the time previously spent elaborating the notes in lectures to be used for activities that required students to interact with the lecturer and with each other.

However, it was noted that no amount of notes can replace the opportunity for students to ask questions to clarify material. Hence at the beginning of each class time was provided for students to ask questions of the lecturer, similar to the approach described by Lage et al. (2000). In addition, a Feedback activity was created in Moodle (the learning management system used by ANU) so students could ask these questions anonymously if they wished. The teacher would respond to the Feedback activity either via a Forum post or directly in class. This model was designed to provide students with adequate support to understand the readings.

The readings also contained activities set aside specifically for class, which could take the form of an Excel or handwritten exercise. Going through these exercises took up the majority of time in class. It was noted in the first class that students had sufficient access to laptops for there to be sharing between no more than two people for the Excel activities, with students who did not bring laptops to class being encouraged to move around the room to ensure they were sitting next to someone with a laptop (an instruction that was successfully adhered to with a small number of exceptions). Students were given time to complete these exercises (or they could attempt them before class if they wished) and encouraged to share their approaches and solutions with their colleagues. The teacher was also available for questions while students were attempting the exercises and typically wandered around the theatre, answering questions for a small group of students who were tackling the exercise together. After sufficient time to complete the exercises, the teacher modelled an approach to answering the question as feedback for the class. In some senses this was not significantly different from a large tutorial, although the standard 20-student, one-hour tutorial was also held each week in which students went through additional exercises. These tutorials were held in a computer lab to ensure each student had access to a computer during the tutorial.

An additional activity the teacher bought into class was the use of the Votapedia online audience response tool (now unfortunately unavailable – this tool allowed students to answer multiple choice questions by making mobile phone calls, with responses being tallied in real-time in a web browser). This served two purposes: first it was thought that it would be fun for students to see how their answers to questions matched with the rest of the class without having to bring attention to their own answer, and second it allowed the teacher to see which questions and concepts were best and worst understood from the readings and other activities and tailor future classroom focus accordingly. Students were typically asked to provide a response to questions on their own before discussing their answers with their colleagues and were encouraged to try and convince their colleagues of the validity of their answers before the correct answer was revealed.

The aims of these approaches were to have students performing the activities the teacher wanted them to be able to do in-class, in addition to out-of-class studying. In essence a passive component of the learning (in this case the readings) was moved outside of class, with more active components of the learning being moved into class time.

In the first class students were informed of the structure that the course would be taking and the rationale behind the structure. Around this time students were also e-mailed the first part (Part I) of a survey (in July 2012) which asked their views on the importance or otherwise of traditional lectures to their learning and their expectations of the proposed structure for the course. The questions in Part I were primarily directed at answering the first research question: do students value the traditional lecture format compared to other learning activities? A total of 62 students answered at least one question in the first part of the

survey, representing a response rate of 61% of all 101 enrolled students who were e-mailed a link to the survey.

In the final week of classes in the course (in October 2012) students were e-mailed the second part (Part II) of the survey, which asked them their views on the class structure used in Actuarial Techniques and how well it assisted their learning. The questions in Part II were primarily directed at answering the second research question: how do students' perceptions of the use of class time change after being involved in a flipped classroom structure? A total of 50 students (of the 62 students who were involved in the first part of the survey) answered at least one question in the second part of the survey.

Questions asked of the survey respondents are provided in the discussion of results in the next section. The survey was undertaken using the SurveyMonkey web tool.

RESULTS

We start with Part I of the survey, with Table 1 and Table 2 presenting results of questions where students were asked to rank general and university-specific activities that assist learning. A lower rank indicates a higher preference for that activity.

The results from Table 1 clearly indicate that, on average, students perceive they learn most from performing an activity, followed by reading, with listening being the least effective learning activity. However, the results from Table 2 indicate only a clear preference against group study, with slight preferences toward individual study and then lectures over tutorials.

Table 1: Rank the Following Activities in Order of Which You Believe You Learn the Most from

Rank	Reading Text, Graphs, Etc.	Listening to Someone Talk	Performing an Activity
1	14	10	36
2	33	16	11
3	13	34	13
AVERAGE RANK	**1.98**	**2.40**	**1.62**
INDEPENDENCE TEST*	**Pearson Chi-Squared statistic = 47.600 with df = 4 and p-value 0.000**		

** The Pearson Chi-squared test of independence of rankings gives a test statistic of 47.600 and a p-value of 0.000 (df = 4). This indicates there are significant differences in the proportion of students who prefer each of the three different categories of learning activities.*

Table 2: Rank the Following University Activities in Order of Which You Believe You Learn the Most from

Rank	Lectures	Tutorials	Individual Study	Group Study
1	20	12	22	6
2	13	21	18	8
3	20	20	15	5
4	7	7	5	41
AVERAGE RANK	**2.23**	**2.37**	**2.02**	**3.35**
INDEPENDENCE TEST*	**Pearson Chi-Squared statistic = 87.733 with df = 9 and p-value 0.000 or if "Group Study" removed as an option = 13.800 with df = 4 and p-value 0.0080**			

** The Pearson Chi-squared test of independence of rankings gives a test statistic of 87.733 and a p-value of 0.000 (df = 9). This indicates there are significant differences in the proportion of students who prefer each of the four university learning activities. Removing the "Group study" preference from this question by collapsing these results into a 3x3 contingency table and re-running the Pearson Chi-Squared test gives a test statistic of 13.800 and a p-value of 0.0080 (df = 4). The slight preference toward individual study and then lectures over tutorials remains.*

Interestingly, when viewing only the responses of students who do not use English as a primary language of communication outside of the university (57% of respondents), the lecture overtakes individual study as the most preferred learning activity, although again there are not large differences between lectures, individual study and tutorials. One reason for the preference against group study might be the paucity of

enforced group activities in earlier courses in the Bachelor of Actuarial Studies, meaning students have had little opportunity to experience group learning.

Put together, these results demonstrate the perceived value students have of large lecture classes, although not as strongly where the large class is used only as a didactic lecture. They indicate that a flipped classroom approach could be perceived as a positive approach to the university classroom due to its combination of activity and demonstration. The results also show the variety of perceived values that students have of different activities, meaning a variety of different learning opportunities will have the best chance of providing a well-perceived learning experience across the student body.

Students were also given an opportunity to answer open-ended questions about the strengths and weaknesses of lectures as a university activity.

The responses to strengths of lectures were extremely varied and hard to pin down significant consistencies. The categories and keywords that were most regularly reflected in the comments were that of the "demonstration" and "clarification" aspects of lectures, e.g.

> *(Lecturers) add their own insight and background knowledge which is often very useful in allowing the student to better understand the material.*
>
> *Lectures provide good clarification of topics. I find it much easier to learn something when someone explains it rather than having to read it in a textbook.*

Other comments focussed on the organizational and even social aspects of lectures, e.g.

> *(Lectures) keep attending students up to date with material covered, and provide a sense of belonging to the university.*

Somewhat disappointingly, only one response identified the motivating aspect of lectures:

> *Initiating discussion on topics, enjoying lecturers' presenting style, motivation to learn more on topics discussed.*

These varied responses demonstrate that students still place a significant value on time spent in lectures.

Responses to weaknesses of lectures tended to focus on issues of class size, speed and engagement, e.g.

> *Too many students in each class means the lecturer can't target what people don't know.*
>
> *Pace of lecture does not suit everyone.*
>
> *The using of course outlines compress materials of that particular section to a single lecture. Hence, becoming a 'touch and go' session. Everything breaks down when encounter problems that require in-depth understanding of that particular sub-topic.*
>
> *It's generally a one-way learning process.*
>
> *(Lecturers) usually do not push us to think and be creative; instead, they sometimes fool us into the belief of having spent enough time studying until we reach the end of the semester.*

Each of the three issues of class size, speed and engagement was found in approximately one quarter of responses.

This variety of perceptions is demonstrated by the very even Yes/No 47.5%/52.5% response rate to the question ending Part I – "Do you believe your learning would suffer if lectures were replaced by comprehensive notes, with lecture time used to answer problems and share ideas with other students and the teacher about the course material?" Some used the open ended portion of this question (where respondents were asked to explain their answer) to enthusiastically clarify their "No", e.g.

> *I think that is what university should be!*
>
> *In university we should learn to study by ourselves and also share or debate ideas with people.*

Others showed an understandable concern that the "comprehensive notes" would not be sufficient compared to lecturer insight, e.g.

> *Lectures are the sole avenue of having someone qualified to discuss ideas and demonstrate them. It is also the only avenue to clarify possible misconceptions in the lecture notes (no matter how comprehensive it could be) due to the wordings or the sentence structure. Further, it is often more effective for information to be verbally transmitted.*

Other concerns were that students would not be sufficiently organized to do pre-class activities and that students are not confident enough to contribute in class, e.g.

> *I do not read the lecture materials before class, so my first contact with the lecture materials is through the lecturer's explanation. Then when I go back to study on my own outside, I find that I can understand better.*
>
> *Seeing the low participation rates when lecturers ask students a question, lectures dedicated just to share ideas will be met with awkward silences.*

The clear differences of opinion on this issue demonstrate the need to be very careful when using a flipped classroom approach – a balance between active classroom activities and demonstration/clarification is important. The author's view on the issue of whether students are organized enough to do the (not particularly significant) pre-class reading is to place the responsibility on the students themselves, although with appropriate warning and discussion of the difficulty in following in-class activities if the reading is not completed. Prior research recommends the inclusion of in-class quizzes before moving onto interactive activities, to further encourage the completion of pre-class activities (see Bishop and Verleger, 2013). However one wonders if such a penal approach to this issue actually encourages the practice of self-directed learning, which is a skill that will serve students well in their postgraduate study and career.

In Part II of the survey three Yes/No questions were asked, with each having an opened ended section allowing students to explain their answers. The results of the Yes/No questions are summarized in Table 3, with results split by respondent answers to the final question of Part I of the survey.

Respondents gave largely positive feedback on the class structure, in particular that sufficient opportunity was given for clarification to be sought, e.g.

> *The discussion forum was a convenient and transparent medium where students could ask questions and look at responses to other people's questions.*

> *Lots of forums available on (Moodle), anonymity was particularly helpful so that I won't be embarrassed to ask silly questions.*

This is particularly encouraging given the significant concern of students at the commencement of the course about the opportunities for clarification in a flipped classroom.

These results are largely consistent with the results of the study by Lage et al. (2000), who observed an average score from students of 3.9 across a 1 – 5 Strongly Disagree – Strongly Agree Likert scale from the question "I believe that I learned more economics with this classroom format" upon the introduction of a flipped classroom in an introductory microeconomics course. It is also encouraging to see the strong support of those who took an unfavorable view to the proposed structure at the start of the semester (i.e. those who answered the final question in Part I "Yes"), which for the final overall question in Table 3 is largely the same (17/24 = 71%) as the support of those who took a favorable view (20/25 = 80%). Finally, it should be noted of the potential for bias in the responses due to those more engaged in the course being more likely to respond, although the response rate is relatively high and the attendance rate at class for the course was the highest the teacher had ever experienced over eight years of university teaching.

Table 3: Yes/No Questions of Part II of the Survey

Question	**Favorable View of Flipped Classroom at Start of Semester (Yes/Responses)**	**Unfavorable View of Flipped Classroom at Start of Semester (Yes/Responses)**
Did you feel like you had sufficient support (from the notes, teacher, tutor and other students) to learn during the course?	22 / 25 ***	20 / 24 ***
Did you feel that sufficient opportunity was given to students to ask questions of clarification to the teacher (either in class or through the Feedback on Moodle)?	25 / 25 ***	21 / 24 ***
Overall, do you believe the way class time was used in Actuarial Techniques this semester was more beneficial to your learning than a typical lecture format?	20 / 25 ***	17 / 24 **

//*** means results are significant at the 10% / 5% / 1% level compared to a null hypothesis that 50% of respondents will answer YES compared to an alternative hypothesis that more than 50% will answer YES.*

The number of open-ended responses was far fewer in Part II of the survey than Part I, most likely because of the shorter amount of time available to students at the end of the semester (due to exam preparation) than at the start of the semester. Hence, it was difficult to determine categorical trends in the responses. Positive comments on the lecture experience related mostly to the application of concepts in class and the interactivity of the class, and reflected the deep learning experience of these individuals in the course, e.g.

> *I believe I got more exposure to the questions directly because I believe it is more important to know how to apply the knowledge you obtain rather than just knowing it. This is because I believe there is a major difference between understanding a theory and applying it.*

> *Engaging and actually having a go at the problem beforehand allowed me to learn more and understand where I needed help in the problem.*

> *(The) lecturer encouraged us to discuss our ideas with other students in lecture, which I found very useful because we helped each other understand the concepts.*

Concerns that were expressed by students related chiefly to the requirement to do pre-reading, and unhappiness with the general structure of the course, e.g.

> *Most of the time, students do not prepare ahead (although this is supposed to be the way). In this case, time spent in class doing questions is sometimes inefficient as students have yet to study the relevant materials.*
>
> *Lectures are meant to inform students about new concepts and ideas. Whilst it is good that we can practice, most of the time is spent waiting on the others to finish…. I'd rather review those lecture exercises at home after some hint.*

CONCLUDING COMMENTS

This paper has considered the value that students place on the traditional lecture format compared to other learning activities and how students' perceptions of the use of class time changes after being involved in a flipped classroom structure. This flipped classroom structure was run in a compulsory final-year course in the undergraduate actuarial program at the Australian National University (ANU), with students taking a two-part survey at the start and end of course to investigate how perceptions of the use of class time change.

Student response to the flipped classroom structure of Actuarial Techniques was largely positive, indicating it to be an approach worth pursuing in future years. While around a 50/50 split of respondents thought the proposed structure would be beneficial at the start of semester, by the end of the semester over 75% of total respondents viewed the flipped classroom as being beneficial to their learning experience compared to a didactic lecture structure. The 25% of students who viewed the flipped classroom as not being beneficial to learning is relatively consistent with the 32% in Schullery et al. (2011) and the 20% in Bates and Galloway (2012).

However, there is still room for improvement in the student learning experience. Looking first at the feedback from respondents to Part I and Part II of the survey, it would be helpful to some students to have a short, pre-recorded (perhaps video) lecture on each topic available in addition to the course notes. This would form an optional part of the pre-reading for each topic and would assist in making the pre-class preparation time more efficient for students. As stated previously, the author is of the opinion that organization issues relating to student pre-preparation is a skill students need to develop for themselves, although a further incentive/threat could be considered in the form of semi-regular in-class quizzes. It would also be useful to have informal extension activities available in-class to those who feel they are being held back by those who haven't done sufficient pre-preparation.

In addition, it should be noted that the results of this study, while considering student perceptions of learning experience, make no comment on the success (or otherwise) of the students in the attainment of the desired learning outcomes of the course. While the literature provides some evidence that active engagement in class improves attainment of learning outcomes, additional data would be required to make that statement in relation to the course considered in this study. However, at the very least, a flipped classroom structure makes it easier to give students the opportunity to practice in-class what they are learning, which is consistent with the constructive alignment approach recommended by Biggs and Tang (2007). Further research could investigate the effect of a flipped classroom structure on the attainment of learning outcomes.

Finally, it is important to consider the academic time taken to deliver a course using a flipped classroom approach. Research and service requirements place significant pressure on many academics to ensure that the time spent teaching is used as efficiently as possible. Course structures that place a significant time

and/or resource burden on academics and/or the university are unlikely to be sustainable. The experience in teaching Actuarial Techniques using a flipped classroom approach for the first time was of an increasing time taken in initial preparation, due to the need to ensure the course notes were sufficiently comprehensive and that in-class exercises were prepared. However, the preparation required before class was much shorter. This was because it was not necessary to prepare for the "performance" of a lecture but simply to be available to answer questions based on the exercises already prepared and to provide a demonstration of how to solve these exercises to the class. In addition, while the initial preparation will not need to be repeated, the benefit of shorter pre-class preparation will continue to be experienced in the future running of the course. Hence, it is possible to run a course in this way without spending significant additional academic time in preparation. These observations are consistent with those of Lage et al. (2000).

The income of many universities is becoming less driven by government and other support and more by student income. Given the improved experience for students noted in this and other studies, and the neutral cost in academic time and resources, academics have a duty to students to explore more engaging and interactive ways of presenting courses such as (but not limited to) flipped classroom approaches.

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BIOGRAPHY

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