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ABSTRACT

If experiential learning activities support engagement and deeper student learning, student-owned experiments constructed "from the ground up" might have benefits that exceed pre-designed classroom experiences. This paper provides a framework for embedding a custom experiment project within an existing course. Students manage every aspect of the process, from experimental design to analysis. Two example implementations are described. Undergraduate behavioral economics students created original experiments, exploring anchoring and adjustment in the context of pyramid scheme pitches (in spring 2013) and reciprocity in attraction (in fall 2014). Perceived benefits and potential pitfalls are explored. While this paper does not represent a controlled study of student learning or engagement, both student reflection and instructor observation support the continued use of this pedagogical approach.

1. Introduction

Experiential learning encompasses a spectrum of teaching techniques, all seeking to convert the passive listener into the active and engaged participant (Hawtrey, 2007). One such technique, the pre-designed classroom experiment, has been found to improve student engagement, attitudes toward economics, knowledge retention and, in some cases, short-term test performance (e.g., Durham et al., 2007). From the instructor perspective, classroom experiments can make teaching more interactive and bring the worlds of research and teaching closer together (Kaplan and Balkenborg, 2010). Such experiences are often short (i.e., one class period or less) classic experiments, but can also take the form of longer-term, student-directed, original projects.

The purpose of a short, pre-designed experiment – one where roles, rules, incentives and calculation sheets are fixed and provided at the outset – is typically to teach or enhance student understanding of a particular economic concept. Given the wide availability of examples and classroom materials, this is a relatively low cost pedagogical approach, often understood to be "at least as good as" traditional lectures (Cartwright and Stepanova, 2012). While past research has identified benefits of such experiments for students and instructors, it has also revealed limitations. Cartwright and Stepanova found that learning is not significantly improved by pre-designed experiment participation unless the experience is followed by assessment, typically in the form of reflection and data analysis. Experiment type also affects outcomes, with greater benefits found when experiments are more involved, taking a significant amount of class time and requiring multiple decisions (Durham et al., 2007). Students who participate in pre-designed classroom experiments remain passive in many ways, given that they cannot design or change the rules and may not make personal connections between the overall curriculum and the experiment (Egbert and Mertins, 2010). Such experiments typically ask students to operate individually, rather than emphasizing team-oriented skills useful in future academic and professional experiences.

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Table 1
Sample schedule of experiment activities (time out of 180 contact min/week).

Week	Activity
1	20 min: discuss experiment learning objectives, team responsibilities, and initial student interests (based on pre-class student interest inventory, sent via email)
2	20 min: discuss primary interest areas and possible corresponding research questions
3	60 min: vote on final interest area, identify 3–4 possible research questions in this area with corresponding behavioral theory and description of possible experimental approach Outside of class: (1) use shared document to make list of lessons from course readings on experimental economics and (2) use rank vote to identify preferred experimental idea and team assignments
4	20 min: announce winning idea (research question and connected behavioral theory with draft design) and team assignments, with short initial team meetings
5	60 min: discuss supplemental experimental/theoretical readings (chosen due to relevance to experimental idea) and implications for experiment design
6	30 min: finalize experimental design in shared document and answer team questions
7	Outside of class: IRB Team posts draft consent forms and IRB proposal for peer/instructor comment, other teams post ideas/documents as applicable
8	No activities—midterm exam
9	5–20 min: team updates as needed
10	5–20 min: team updates as needed
11	20 min: Debrief Team presents to class Outside of class: test experiment with small group of recruited subjects
12	5–20 min: team updates as needed
13	Outside of class: experiment conducted outside of class (evening), resulting data posted to class site, analysis team evaluates data and prepares presentation
14	45 min: discussion of results and reflection on findings, lessons, improvements
15	Outside of class: self/peer assessment of team contributions and anonymous learning objectives reflection or essay
16	No activities—final exam

In contrast, custom experimental projects seek to enhance engagement by giving students control over experimental design, implementation, and analysis. Such projects emphasize teamwork and critical thinking as students must work together through the full process, from identification of the research question to analysis of experiment results. While this pedagogical approach aims to strengthen the students' understanding of experiments as a methodology in economics, it can simultaneously seek to enhance understanding of the economic concept(s) at the heart of the experiment (Egbert and Mertins, 2010). This paper will not provide quantitative evidence of enhanced conceptual learning,[1] but will argue that both methodology and theory are best studied together, challenging students to understand the "what we know" and "how we know it" in tandem. If a course incorporates pre-designed experiments and a custom experiment project, students have the experience of being both subjects and creators. This provides exposure to multiple perspectives, enriching both learning experiences.

While custom experimentation is less conducive to ready-to-print handouts and resources, this paper provides a framework for a term-long experiential project, set within an undergraduate behavioral economics course. Rather than creating a variation of an existing experiment (as in Egbert and Mertins, 2010), students design a custom economic experiment "from the ground up." Two examples of such projects are described, as are perceived benefits and potential pitfalls. The pedagogical approach outlined within builds on existing literature by emphasizing the aspects of experiments that seem most important: significant involvement (i.e., complexity of engagement), connected assessment, student-directed learning, and perceived relevance.

2. Learning objectives and course structure

In terms of specific learning objectives, students who participate in the "ground up" experiment will: (1) demonstrate knowledge of a behavioral economic theory, connect that theory to an authentic problem, and design a research question intended to test that theory, (2) apply knowledge of experimental economics by designing and implementing an experiment that investigates the defined research question, (3) connect theory to practice by comparing subject behavior to theoretical expectations, (4) articulate the knowledge gained and clearly identify limitations, identifying experimental improvements, and (5) demonstrate commitment to this shared, student-owned learning experience.

The learning objectives for the embedded experiment fit within the larger learning objectives of the course. The example implementations described in this paper are set within an undergraduate behavioral economics course at a small, private liberal arts university. This is an elective course, suitable for both economics minors and majors. Prerequisites include principles of microeconomics and macroeconomics, statistics, and calculus or business analytics. The average class size has

[1] Formal pre/post capture of conceptual knowledge is suggested for future iterations.

been 18 students, though multiple experiments could be created within a larger class.[2] The course topics[3] include standard content for a behavioral economics course based on the Angner (2012) textbook as well as various readings on experimental economics (including Binmore, 1999; Falk and Heckman, 2009; Levitt and List, 2007; Roth, 1994; Santos, 2009; Smith, 1994). As this course naturally includes discussion of lab and field experimentation, these readings would be incorporated in the course even if not for the custom experiment project. The same can be said for time devoted to trying out classic experiments (e.g., public goods game, trust game, etc.) as they are typically viewed as an essential part of behavioral economics curriculum.

The group experiment project did introduce some changes into the course schedule. Additional supplemental readings were added in each term based on the experimental topic that semester. For example, when the students chose to study reciprocity in attraction, we supplemented textbook content on reciprocity with additional journal articles on dating experiments and reciprocity research. We also allocated portions of specific class sessions to discussion of the project. Table 1 provides an example of classroom activities that supported the project.[4] Within this example, approximately 10% of class time was dedicated to the group experiment. All other activities connected to the project (e.g., team meetings) occurred outside of formal class meetings. The in-class time was contained, to some degree, through the use of discussion forums and shared documents, facilitating collaboration outside of class meetings. In conjunction with these digital tools, in-class discussions were used to develop a common understanding of the experimental design, identify interdependencies between teams, and address obstacles or questions at each stage.

Experiment teams included IRB (institutional review board) approval, debrief, subject interface, and promotion, sign-up & logistics. The IRB Approval team was responsible for preparing the pre and post-consent forms (for prior to experiment start and after debrief) and the IRB proposal. After presenting the proposal to the class for revisions, this team submitted the experiment proposal directly to the university's IRB committee. Debrief members created a post-experiment presentation that would be presented to subjects. This team also fielded questions from subjects following the debrief presentation. Subject interface created subject instructions and all computer-based or other materials to meet experiment-specific needs. Promotion, sign-up & logistics managed experiment promotion, subject sign-up and all other logistical needs (e.g., space reservations) for the on-campus experiment. This team also recruited a small group of subjects (5–8) to test the experiment two weeks prior to the formal experiment. Adjustments may be needed based on class size or specific experiment requirements.

Based on student feedback and instructor reflection, a specific analytics team will be added in future iterations of this project. Students provided ranked preferences so that they could be assigned to teams based on personal interest and self-assessed abilities. The experiment accounted for 20% of the student's overall course grade, where the group experiment grade was based on the following components: peer and self assessment within each team, instructor observation of individual contributions, and submission of individual experiment reflection.

In the following section, two example implementations of "from the ground up" experiments are discussed: (1) pyramid schemes and enhanced disclosure and (2) reciprocity in attraction. These examples are followed by a discussion of perceived benefits of this pedagogical approach as well as potential pitfalls and adjustments.

3. Example 1—pyramid schemes and enhanced disclosure

In the spring 2013 term, we set the stage for the experiment project by discussing pyramid scheme fraud, a subject connected to instructor research. As this was the first iteration of a "from the ground up" experiment, the class decided to adopt this topic as their own, especially given recent events that highlighted the presence of such schemes on college campuses. In all future iterations, students would choose their own authentic problem.

Students ultimately decided to create a mock pyramid scheme to explore individual choice and potential cognitive bias. The scheme would be presented as a business opportunity and modeled after promotional materials of indicted firms. With this backdrop in mind, students began discussing relevant aspects of behavioral theory. After selecting multiple connected concepts (including herding and social preferences), students settled on the concept of anchoring and adjustment and its connection to pre-sale income disclosures. This choice was partly due to the practical ease of altering provided disclosures but was further motivated by active national discussions on disclosure regulation. Both our textbook (Angner, 2012) and various assigned readings (including Rabin, 1998 and Kahneman, 2011) defined anchoring and adjustment as the often unconscious selection of an initial value and movement away from that initial value. This heuristic is often used for the estimation of an uncertain value and marketers who understand this concept can strategically insert an anchor to alter behavior.

Anchors are utilized within business opportunity pitches when pre-sale income disclosures are given to potential recruits. Disclosures often attempt to create an anchor by emphasizing the highest and least probable income values. Adjustment away from the anchor is limited by excluding all participants who failed to earn commissions. Students

[2] Ideal group size may depend on the complexity of the experiment but a typical situation would include 5 teams of 4 students per team, or 20 students per experiment group.

[3] The corresponding fall 2014 course syllabus for Behavioral Economics can be found at http://tinyurl.com/gvp4nmc.

[4] The activities and time allocation described in Table 1 correspond most closely with the fall 2014 implementation described in a subsequent section.

hypothesized that an enhanced disclosure (one that included more information to show all participants who earned $0 in commissions) would cause participants to adjust expectations downward, further from the anchor, than those who had the typical disclosure. If true, this could help to deter scheme participation, at least on the margin. This research question connected a behavioral theory to our authentic problem. It also highlighted a methodological strength of experimental economics in that it focused on the testing of a potential public policy or regulation (Smith, 1994; Holt, 2003; Falk and Heckman, 2009).

Ethics were at the forefront of our classroom conversations. To protect subjects, students recognized that the experiment would require a robust debrief, explaining the experiment to inform post-consent and educating participants on pyramid scheme warning signs. To protect themselves, students decided to pitch the business opportunity by creating a website with embedded testimonial videos rather than pitching directly to college peers. Economic literature within our course curriculum emphasized the need to limit deception and to measure observed behavior rather than behavioral intentions wherever possible. To this end, students decided to advertise the experiment as a "Market Research Study," asking participants to react to company-provided (scheme) information. Participants were also paid ($15 for 1 h commitment) and any ultimate decision to join the scheme would require the subject to voluntarily forego two-thirds of this payment as a join fee.

Recruited subjects, 28 undergraduate students, were instructed to look at multiple pages on the student-created website, listen to embedded testimonial videos, and look at an Income Disclosure form (representing participant income from the prior year). Half of the subjects were randomly chosen for the control group (traditional disclosure) and the other half assigned to the treatment group (enhanced disclosure). Subjects then responded to a series of questions. At no time were they allowed to communicate with fellow subjects. Students captured the data that was anonymously reported on subject questionnaires.[5]

None of the subjects forfeited $10 to join the fictional scheme, "TraVenture," during the 1-h period but 8 did indicate interest in attending an additional information session. Students noted that some of the results matched theoretical expectations in that subject statements of expected earnings and likelihood of success did fall (as measured by the median response) when more information was provided to facilitate adjustment from the anchor (i.e., highest income at the top of the table). Many realized that the average expected earnings were skewed by a single treatment group subject who reported expected earnings of $12,000 per month. As a result of this individual, mean expected earnings in the treatment group exceeded that of the control group. The enhanced disclosure also failed to discourage 4 subjects in the treatment group (same number as in the control group) from being interested in an additional information session. Matching expectations, those interested in attending an information session reported higher expected earnings and likelihood of success than those who were not interested.

We discussed the fact that no subjects in either the treatment or control groups opted to join the company. Was this a failure of experimental design? Is this a "good" or "bad" result? Discussion led to a possible role for the endowment effect as subjects would need to forego a large share of the payment to join TraVenture and may have already perceived the payment as personal property. While the experiment was built to test the theory of anchoring and adjustment, the experience allowed students to consider the possible role of other behavioral concepts they had learned within the course curriculum.

As we did capture subject gender, data showed that 6 subjects were male and 22 female. This prompted much discussion as to the potential reasons for an uneven gender balance in the sample (e.g., gender differences in pro-social behavior—a topic we had discussed within the course). Though based on a very small sample size, students were interested to find that male subjects did report higher expected earnings and a higher likelihood of success. This allowed us to discuss literature on gender differences in risk attitudes and earnings expectations. While this literature was not a standard part of the behavioral course (with the exception of risk preferences), it allowed students to connect findings with curriculum from other economics courses, namely labor economics. On balance, students were pleased with the design and execution of the experiment. They identified changes that could be made to a next iteration (e.g., enhanced recruitment with an eye on gender balance), in the hopes that such an experiment would be refined and repeated in the future.

4. Example 2—reciprocity in attraction

In the spring 2014 term, students began the task of selecting an authentic problem for their own experiment. After narrowing the broad topics to dating/attraction, student spending habits, and corruption, they then worked on possible research questions within those areas of inquiry. Students ultimately selected dating/attraction and, at this stage, had preliminary discussions of possible behavioral concepts and connected experiment designs. Students collectively decided on a single research question, based on interest and perceived feasibility: the impact of reciprocity on physical attraction.

Once this research question was identified, we supplemented earlier readings on experimental methodology with existing experiments in dating and attraction (e.g., Fisman et al., 2006; Nataf and Wallsten, 2013). This allowed students to further imagine multiple possibilities for design and implementation. We also read forward in our textbook to read Angner's discussion of reciprocity and discussed recent experimental research on reciprocity in behavior (e.g., Herne et al., 2013).

Students ultimately designed an experiment with the following components:

[5] While contact information was captured, subjects witnessed the separation of such contact information from the questionnaire responses after the conclusion of the experiment to ensure anonymity in analysis.

- Subjects were recruited with an understanding that a personal picture (student ID photo or other contributed photo) would be sent anonymously to a set of students in another university. If consent was not given for photo sharing, they did not participate in the experiment.
- Subjects would be paid $10 for their participation in the experiment (30–60 min).
- Subjects would rate an assortment of pictures, providing a rating of attractiveness for each photo. This rating would not be shared with the person in the photo. Photos were taken from a stock of photos available for research purposes.
- Fabricated ratings would be provided to some subjects. Those ratings would be calculated based on an initial self-rating provided by the subject at the start of the experiment. For example, if the subject provided a self-rating of 7 (out of 10), some high ratings (8–10) and some low ratings (4–6) would be generated. These fabricated ratings appeared underneath each photo (i.e., "This person rated you a 7") before the subject rated the photo.
- Subjects were divided into three groups:
  - Control group—received no ratings from those in the photos.
- Treatment group 1—received fabricated ratings from those in the photos, with the last few ratings being quite high relative to the self-rating.
- Treatment group 2—received fabricated ratings from those in the photos, with the last few ratings being quite low relative to the self-rating.

- Those in treatment groups 1 and 2 received no rating from the very last photo, so needed to rate in the absence of that missing information.

Students hypothesized that subjects would exhibit positive reciprocity, awarding higher ratings to photos that gave them high ratings (i.e., ratings exceeding self-ratings). Similarly, they expected to observe negative reciprocity, with subjects assigning lower ratings to photos that gave them low ratings. Lastly, they hypothesized that subject ratings would demonstrate indirect reciprocity, rewarding the last photo (that did not provide a rating to the subject) if the subject had recently experienced high ratings and punishing the last photo if the subject had recently experienced low ratings. The debrief process would explain these hypotheses, discuss the limited degree of deception (i.e., that their pictures had never been sent or rated by others), and inform subjects of their right to withdraw their data from the study but maintain full pay.

Of the 30 recruited subjects (15 males and 15 females), all signed post-consent and authorized the use of their data within the experiment. Overall, analysis revealed evidence of reciprocity, both negative and positive, but failed to show evidence of indirect reciprocity. On average, subjects who received a high rating, in turn, awarded a rating that was 0.46 points higher than the control group and 0.83 points higher than the "low group." Separating the subjects by gender revealed stark differences in behavior. Male subjects awarded higher ratings than the control group, whether they had received a high or low rating from the photos. Though they still rewarded the high ratings the most, giving a 1.58 point bonus to photos who rated them highly, it seemed that male ratings were elevated in general simply by being personally rated. On the contrary, female ratings were suppressed in general when they received personal ratings. While exacting the greatest penalties when they received low ratings (an average penalty of 1.37 points relative to the control group), female ratings were lower for all photos when being rated themselves.

While it was difficult to know the exact mechanism at work, it was clear that this was an indication of a potentially interesting discovery. If this were to be pursued further, students noted the need to replicate the experiment with larger numbers of subjects and to explore the theoretical grounding for such a finding. We also spent time discussing the implications of such a finding. What implications would these results, if confirmed, have for dating markets? Would these findings extend to other aspects of human interaction that involve reciprocity?

5. Perceived benefits

As suggested by Cartwright and Stepanova (2012), students in both terms were asked to reflect on the experiment. The spring 2013 students were asked to write an essay while the fall 2014 students were given an anonymous survey to illicit responses based on the intended experiment learning objectives. Additional anonymous comments were drawn from institutional course evaluations in both terms. Responses fell into two main categories: reactions to the experimental findings and perspectives on the process as a whole. In terms of experimental findings, students noted that the ability to generalize from these results was limited by the sample size and by the potentially biased nature of the subject pool (undergraduate college students and, in one case, largely female). They also realized that results should be interpreted with caution, especially as a single subject was capable of altering the results. As a student noted, "One tricky part of experiment (al) economics is the way data is chosen to be represented. This can lead to a balance between making sense of results and inaccurately representing the data."

One student reflected on the differences between natural science experiments and the social science context and discussed the "tradeoff between control and realism" in an experiment.

Many students commented on the importance of the initial experimental design. In one student's words, "Being a part of the process from the design through conducting the actual experiment illustrated the need for an understanding of the theory or method being tested to ensure that the experiment addresses the appropriate question."

More broadly, students discussed the critical focus on ethical considerations, the connection to theoretical concepts, and the general skills introduced by the full process. They also spoke directly to the custom nature of the experiment and the shared ownership of the experience. Some comments included:

"No matter the results, the experiment was useful for applying and studying concepts covered in class."

"Our experiment was *so much more* than just 'the experiment'."

"The fact that our experiment was original was a point of pride, and (I hope!) motivated our class to put in their best efforts and ideas."

"In this course, the inclusion of an experiment and scholarly article presentations put the learning in the students' hands."

"This course is one that has really provided a connection between class learning and real-world application. The content that was covered, including the experiment, was useful and made me aware of the way behavioral economics concepts can be used explain/understand everyday occurrences."

The caution articulated in responses indicates that these students were thinking carefully and critically when drawing empirical conclusions from a relatively small experiment, best viewed as a pilot experiment. Ownership of the process caused them to feel a greater responsibility when interpreting the results of that process. In terms of teamwork, students recognized the contributions of their fellow team members but also of other teams. Creation of the experiment "from the ground up" did seem to foster dedication and enthusiasm. Student comments reveal that the project was perceived as enhancing knowledge of both methodology and the behavioral theory being tested.

Both students and instructor recognized the pilot nature of the experiment projects, created within a single academic term. In both examples provided, outcomes were intriguing and potential improvements were identified. Results could prompt interest in refinement and continued experimentation beyond the academic term, based on instructor and/or student desire, inspiring additional research.

6. Potential pitfalls

A few students in the spring 2013 term commented on the opportunity cost of the experiment in terms of reduced time spent on textbook problems and literature discussion. This concern was not expressed in the fall 2014 implementation (even under anonymity), as the scale of the experiment was more carefully managed. It was rewarding, both for students and the instructor, to create an experiment that was embedded in the instructor's research agenda. However, this may have altered the process somewhat, making it more difficult to scale the experiment to a single-term project. This problem could also be attributable to the fact that it was the first implementation of this teaching technique. It is especially important to help the students anticipate the logistical and/or technical work required by the proposed experiment design. Beyond scaling the project appropriately, it is helpful to discuss the group experiment at the start of the course to make expectations immediately explicit. It may be helpful to include in the course description and/or title. For example, the title for the course discussed in this paper has now been changed to Behavioral and Experimental Economics.

Beyond appropriate scale and transparency, there must be a balance between full student-ownership and the appropriate level of instructor guidance. In the fall 2014 experiment, for example, students should have been guided away from the use of deception within the experiment design. This will be most important in the early stages of the design process, making in-class discussions essential in the early weeks. The IRB team is also likely to need early guidance to ensure a successful and timely submission. As with any group project, team chemistry and relative workload may need to be observed and managed.

In terms of student ownership, students did not take responsibility for the analysis stage in either of the two examples presented, though they participated in the discussion of results. This was attributable to two factors: (1) it was not explicitly included in team responsibilities and (2) the experiments took place too close to the end of the term (in both cases, in week 14, rather than week 13 as suggested in Table 1). Course prerequisites and instructor observation suggest that students can and should take the lead in analyzing the experiment results. Students can prepare for this responsibility by analyzing mock and test data. It is helpful to schedule the formal experiment date/time early in the term to ensure a sufficiently aggressive timetable.

It can be challenging to recruit subjects and, while a reasonable number of subjects were ultimately recruited in both implementations, we did not have enough potential subjects to utilize a sampling approach. A symbiotic partnership could be established with introductory economics courses so that introductory students, or some subset, would serve as subjects. While this could exacerbate sample selection bias, the benefits to students might outweigh this concern. In practice, we believe that a sizeable share of our subjects ultimately came from business and economics, as our promotion team advertised heavily in these courses. Funding was provided by the instructor's academic dean but a $15 student fee was added in the second implementation to offset a majority of the costs.

The custom experiment approach requires some degree of flexibility, as the instructor may need to introduce concepts that seem relevant to the class discussions earlier than planned. When students began discussing pyramid scheme participation, concepts such as herding, social preferences and anchoring were briefly introduced to provide language and theoretical concepts that matched the student discussions. When the students settled on anchoring and adjustment, we then needed to spend more time on those concepts to support experiment design, even if the topic was slated for a later week. The same was true of reciprocity, as social preferences were scheduled for late in the term (based on textbook placement) but were moved forward in the course to support design discussions.

7. Conclusions

Building an experiment "from the ground up" holds the promise of significant experiential learning—asking students to drive the learning experience from start to finish in an active and authentic way. Students who engaged in this process were highly motivated, both to contribute to their team and to the experiment as a whole. It was clear from the start that the entire experience would fail if teams did not fulfill their respective roles. While this project was not treated as a formal experiment of teaching and learning (e.g., with pre-test and post-test or a control group), student reflections indicate strong appreciation for the connection "between class learning and real world application" and for the promise and limitations of experimental findings. The process itself unearthed meaningful conversations, creating connections with other behavioral concepts and with other subfields within economics. The act of creating a connection between a theory and an appropriate experimental design invoked critical thinking in a context that was new to most students.

Students participated in interpretation of results and reflected on the experience, both to strengthen their own learning and to provide useful feedback. Future changes include the establishment of a student analytics team paired with a slightly more aggressive timetable, ensuring sufficient time for interpretation of results. To measure the impact on student understanding of conceptual knowledge, the instructor could test the theoretical concept at multiple points in the term to see if the experimental project deepened theoretical knowledge.

Overall, both instructor observation and student reflection support the continued use of this teaching technique. The custom experiment approach holds the promise of enhancing student learning of both theory and method, emphasizing them in tandem. Teamwork, ethical deliberation and critical thinking are central to the project. Students embrace the opportunity to move past passive learning of concepts and research techniques, acting as economists to create knowledge.

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