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Shifting Departmental Culture to Re-Situate Learning

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Shifting Departmental Culture to Re-Situate Learning

1. Introduction

This paper presents our initial efforts in *revolutionizing* the undergraduate learning environment in the School of Chemical, Biological, and Environmental Engineering (CBEE) at Oregon State University (OSU). While we currently provide students many innovative learning opportunities, we are concerned that the extent to which these efforts are marginalized and isolated may deter from their influence. To address this issue, we plan to create a holistic, inclusive, professionally-based learning environment woven through both curricular requirements and co-curricular opportunities for students. We specifically target social inequality by seeking to create engineering educational systems and interpersonal interactions that are professionally and personally life-affirming for all people across their differences. We seek to catalyze change through construction of a culture of inclusion and a shift in our learning environments from sequestered activities to realistic, consequential work. This requires a fundamental change in the nature of department culture (values, norms and structure).

Project activities include: (1) curricular redesign of 9 core sophomore- and junior-level studio classes to include more ***realistic, consequential work*** leveraging research-based pedagogies like ***problem-based learning*** and ***model-eliciting activities***; (2) growing faculty and students' ***capacity to engage issues of inclusivity*** by shifting their cognitive and affective knowledge of power and privilege; (3) planning and implementing ***student professional development pods***, longitudinally mixed student teams where students help one another understand the university experience and how it relates to professional practice; and (4) implementing ***formal changes in governing policies and procedures*** within CBEE. In the first stage of this project we have particularly focused on the use of base-line, qualitative data to inform future project activities and on processes to garner broad buy-in for change throughout the unit's community.

This work is supported by the National Science Foundation pilot program *Revolutionizing Engineering Departments* (RED) that is aligned with the NSF Engineering (ENG) Directorate's multi-year initiative, the *Professional Formation of Engineers*, to create and support an innovative and inclusive engineering profession for the 21st Century.

2. Theory of Change

While CBEE has implemented innovative curriculum and has a rich and varied array of co-curricular activities, the professional development of engineers operates within the larger culture of engineering as practiced in industry. This culture has come under fire for privileging a dominant group: white, male, and middle- to upper-class persons who have been successful in upper-level math and science courses in high school. Activity theories[1-3] provide both an explanation for the ongoing existence of the norms and practices within the unit and a framework for inducing change. These theories "situate" individual learning and activity in the social contexts in which they occur. Indeed, Jorhi, Olds, and O'Conner[4] argue that a situative approach in needed to address the complex professional development of engineers. By taking a situative approach, we consider activity *systems* as continually co-constructed through practice, and the parts played in maintaining the systems (and resisting change) by different groups of people, structures, rules, and behaviors becomes clearer. This leads directly to a change strategy. The

time, opportunity, and incentives for restructuring are addressed as part of a system of values that motivates change in practices (or not).

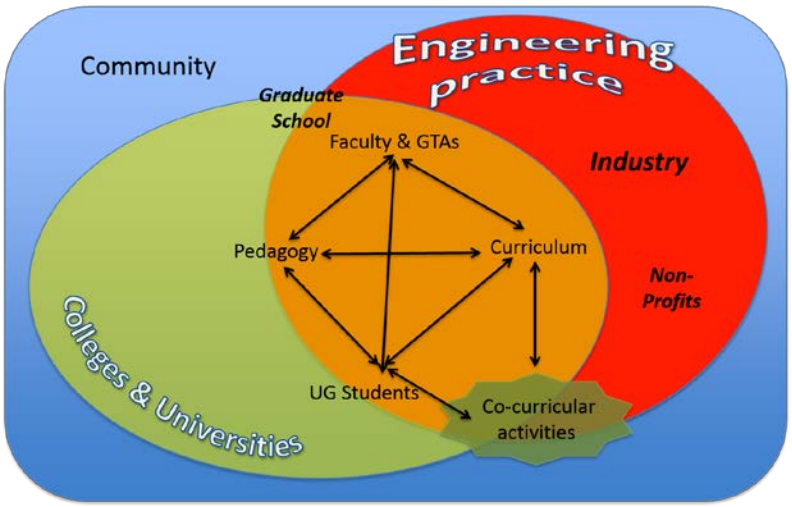

Figure 1. ***Activity Systems in CBEE.*** Multiple interacting components

Figure 1 shows a representation of the CBEE community in terms of multiple constituent components (e.g., people, artifacts, resources). We propose that if our revolution will affect lasting change, we must simultaneously re-situate and re-negotiate these multiple components. The major project activities discussed next address course design, pedagogies, faculty (and GTA) culture, and undergraduate student culture. As illustrated in Figure 1, each component interacts with the others in the activity systems in CBEE.

3.1 Curricular Change in Core Courses

Theoretical Framing and Approach

Curricular change is based on intentional integration of *realistic, consequential work* in nine core sophomore and junior level classes. But, ultimately we envision this approach percolating to all aspects of the CBEE curriculum. In realistic, consequential work, students engage in activities that require them to activate disciplinary knowledge and practices to solve real-world problems. The fundamental principle is to *situate learning* in contexts similar to ways that the content is used in practice.[5] We adopt Engle & Conant's[6] term *productive disciplinary engagement* (PDE) to describe engineering students engaged in exhibiting these characteristics by using the concepts and discourses of engineering to "get somewhere" (develop a process or product, gain better understanding) over time. Engle and her colleagues[7] have shown that interactions characterized by PDE are more likely to result in deep learning of concepts and incorporation of practices.

We draw on elements of demonstrated "authentic" pedagogies that have been adapted by engineering educators, including: *Problem Based Learning*[8-12] and *Model Eliciting Activities*.[13-15] Both these pedagogies place students in small teams (e.g., 3-5 students) with real-world client or manufacturing driven problems. To respond, they need to construct and organize knowledge, consider alternatives, engage in analysis, inquiry, and design, and critique their own reasoning and that of others.[16,17] Problem-Based Learning (PBL) was developed by Barrows[8,9] for the Medical School at McMaster University and has been integrated into engineering curriculum across the globe albeit in niche programs and to a more limited extent in the United States.[19-22] Model-Eliciting Activities (MEA) were originally developed to promote conceptual understanding rather than procedural learning in middle-school mathematics students.[13] Supported by NSF-CCLI funding in 2007, Model-Eliciting Activities have been meaningfully introduced into several engineering disciplines, including industrial engineering, environmental

engineering, chemical engineering, mechanical engineering, electrical and computer engineering, and first year courses,[14] but also have shown limited propagation.

By integrating *realistic, consequential work* into the Core sophomore and junior level courses, we seek to re-situate the learning environment to foster a different relationship between the learner and the activities through which they learn. By the time undergraduate engineering students have reached their senior year, they have generally been successful in the world of engineering school, what we call "School World."[3,22] However these school abilities may function almost completely independently of the real life sense making abilities needed in the world of engineering practice.[13] It is not uncommon to find a student in the engineering classroom who does well on exams but cannot operationalize that same material in project work. We seek to develop learning environments and activities that students are better able to connect what they learn to the "Engineering World" of professional practice.

3.2 Progress to-date and looking forward

For the RED project, we are working towards introducing *realistic, consequential work* through PBL and MEAs in nine required core courses: three sophomore-level, five junior-level, and one first-year. We leverage a recently instituted classroom structure in these courses where lectures are punctuated by activity based *studios*.[23] Enrollment currently ranges from 175 - 300 students in lecture, but the studios are divided into multiple parallel sections of 24-30 students. We choose the studio courses, in part, because it is structurally ready to shift to these pedagogies. In studios, students actively apply concepts and problem-solving procedures as they work in teams. Learning in studio is supported by graduate teaching assistants and instructors who interact with students in a facilitative rather than directive manner. While these critical structural elements are in place, the content currently relies on sequestered, abstract worksheet-based problems.

In Project Year One, we seek to build a foundation for this curricular redesign and specifically to target pilot implementation in the three sophomore-level courses in Project Year 2. This work has required building shared understanding with the instructors of the studio courses. In fall term, we piloted the material developed by one of the studio instructors. We observed and video-taped two redesigned studios and two studios in the original format. We plan to do this again in the winter and spring, and use this data as a baseline for planning in the summer. As this work unfolds, we have recognized critical structural issues with the studios that may need to be addressed to successfully integrate these more challenging pedagogies, including GTA professional development and team formation. We have instituted a dedicated pedagogy seminar that all studio GTAs attend. In this seminar, we have integrated concepts from *Complex Instruction* in mathematics with particular attention to the way students' status impacts their participation on a team and their opportunity to learn.[24,25] We are also working towards more intentional ways for studio team formation, reflection, and interdependence. To this end we have piloted the use of the CATME tool[26] in one studio class. Finally, we have engaged our Industrial Advisory Board (IAB) as a source for problems to integrate in the studio. We have been working with the IAB Chair to develop a process where we can translate the project experiences of our industrial partners into useful studio activities for our students.

4. CREATING A CULTURE OF INCLUSION

4.1 Theoretical Framing and Approach

Harvey[27] describes campus climate as the "culture, habits, decisions, practices, and policies that make up campus life," and this is affected by both structural and interpersonal elements.[28] Faculty members are central to the maintenance of norms, beliefs and practices that underlie their disciplines. Thus, if significant shifts in culture are needed to promote a better sense of belonging and self-empowerment among engineering students who identify with underrepresented groups, faculty will be required to gain a deeper understanding of systems of oppression and privilege**.**

Through activities outlined below, we aspire to shift faculty members' cognitive and affective knowledge of power and privilege through expanded understandings of personal biographies rooted in wider systems of institutionalized inequalities. This educational approach allows for critical examination of how unequal distribution of social, political and economic power becomes enacted in day-to-day personal interactions, and provides for a more sophisticated and nuanced understanding of structural inequalities. This level of understanding has been shown to be lacking in STEM fields[29] and this project seeks to raise awareness of such issues to inspire a collective call to action.

We are leveraging OSU's innovative Difference, Power, and Discrimination (DPD) faculty development program as well as the OSU's ADVANCE summer seminar in order to empower CBEE faculty to engage in culture transformation. These 60-hour seminars are interactive learning experiences centered on analyzing the operations of difference, power, and privilege in higher education, each with slightly different foci. The DPD seminar's emphasis is on critical pedagogies and curricular transformation while the ADAVNCE seminar is adapted for faculty in STEM disciplines and provides opportunities to explore structural inequities within the university. Both seminars help faculty imagine a transformed future in which institutional structures and personal behaviors are both professionally and personally life-affirming for people across their differences. In addition, all CBEE faculty will complete OSU's Search Advocate training program (10-hours). Participants gain skills in recognizing and reducing unconscious, unintentional biases, suggesting ways to increase the validity of the standard search process, and enhancing diversity outcomes throughout the search/selection process (from development of the position description through integration of the new hire into the unit).

We will also address students' capacity to engage issues of inclusivity by affirming students' intersecting social/cultural identities (along axes of gender, race/ethnicity, ability, sexual identity, socioeconomic class, first generation status, and religion, among others), and, thereby, positively affect their sense of belonging within the engineering community and in-turn positively impact persistence and success in formation of their professional engineering identity. As discussed below, we will use the professional development pods as the primary vehicle to engage students in reflection of their situated lived experience as informed by their intersecting social/cultural identities. Students will be encouraged to consider how these identities can be leveraged as assets as they develop their engineering identities, including how their technical skill sets could be used to engage and benefit marginalized communities.

4.2 Progress to-date and looking forward

A CBEE equity, inclusion and diversity taskforce, which includes two faculty from each of the three disciplines in the School as well as professional faculty, has been established to provide strategic leadership in this area. This newly formed group includes members who have completed either the DPD or ADVANCE summer seminars, with other group members enrolled for summer 2016 participation. In addition, three of the project co-PIs have completed one of the summer seminars and the forth is enrolled in Summer 2016. The taskforce will use data recorded from base-line CBEE faculty interviews as well as data from a student survey (administered to first and fourth-year CBEE students) that probes students' perceptions of social responsibility incurred in the engineering profession, to inform paths forward. In addition, promising practices at comparator institutions will be considered and adopted towards the end of transforming institutional inclusivity and equity, particularly as it pertains to equalizing student success across demographics and students' professional development.

By Project Year 3 year, we plan to have 75% of the faculty and staff complete a summer seminar and 75% complete the Search Advocate Program. These faculty and staff will have developed a common language and a critical lens from which to discuss issues arising from difference. Thus, they will be positioned to facilitate deeper conversation with those in our community who have yet to engage the programs described above. To facilitate these conversations, the taskforce will develop educational activities to be delivered during CBEE faculty-retreats and faculty meetings that will focus on relevant, timely issues being faced by our community. For example, an hour presentation and interactive exchange could be developed around stereotype threat, navigating difficult conversations involving difference that arise in the classroom, effective mentoring of LGBTQ students, among other topics. The longer periods of time available during our retreats could be used to present the research findings of the RED project, and to collectively engage in strategizing how barriers to our goals might be overcome. This will provide a greater sense of ownership in the revolution.

5. STUDENT PODS

5.1 Theoretical Framing and Approach

Students have opportunities to participate and develop identities in a number of activity systems in CBEE. Outreach activities, engineering clubs, undergraduate research, and internships can all provide opportunities for legitimate peripheral participation in the activity of professional engineering. At the same time, students are learning to become engineering students in the particular educational systems of our School and are seeking to become professionals in a variety of engineering and social contexts. As they develop their professional identities, they must navigate the different and sometimes conflicting value systems in which they participate. For example, student clubs and service learning experiences may engage in practices that implicitly value quality of life or equitable distribution of resources, but internships or early-career experiences may be more focused on the bottom line and a corporate hierarchy of power. While much of the skills and knowledge may transfer across contexts (e.g., teamwork, communication, problem-solving), the different norms and values of the systems can create very different meanings for those same skills and knowledge. Additionally, the differences between the systems themselves are significant in the development of students' personal and professional identities. For example, as students experience differences between CBEE and examples of

professional engineering activity systems, they may understand CBEE as helping them develop knowledge and skills useful for fuller participation in practice, or alternatively, they may view engineering school as a relatively arbitrary system to "game" in order to graduate with as little effort as possible.

Student Professional Development Pods are intended to provide a place for students to process these experiences and to make sense of the different affordances for "engineering identities" they encounter in the different curricular and co-curricular settings.[29] Unfortunately, there is a cultural conflict between our vision of inclusive practice (revolutionary culture) and many of the environments that students encounter in the profession (engineering practice culture). If we are to avoid the decline in students' engagement with their professional responsibility to human welfare reported by Cech,[30] students will need to process and reflect on such inconsistencies in an environment that supports full voice for paradigms outside of the dominant, normed engineering practice culture. We propose developing and testing Professional Development Pods as a supported and scaffolded way to consider the conflicting notions of what professionals in engineering should be and do as well as the conflicting notions of what it means to participate in CBEE. Built upon Johnson & Johnson's[31] notion of "base groups," the pods will be designed to encourage long-term membership, group identification, intragroup accountability, and significant support among students. By creating pods with members from the sophomore, junior, and capstone years, and by including transfer students, pods can become a venue for cross-group mentoring and perspective-taking. This could support first-generation college students in particular by supporting their participation in co-curricular activities, as well as in connecting learning across courses. In addition to supporting students as they learn to navigate the various contexts in which they learn to be engineers, professional development pods can provide students with a trusted group with whom to discuss discordant experiences within and outside the program. Pods could be especially helpful to members of underrepresented groups, and finding solidarity with others around issues of oppression might also empower students to push instructors toward more equitable practice.[32,33]

5.2 Progress to-date and looking forward

We propose a design-based implementation research plan to explore the feasibility of providing professional development pods to CBEE students in the second and third year of their programs. The first phase of this plan will entail recruiting interested sophomores and juniors to work with faculty to design the initial implementation of pods during the spring of 2016. These co-designers will form the nucleus of the first group of pods; additional sophomores and transfer students will be recruited during the summer for pods established in the fall of 2016. Co-designers will participate in leadership and diversity training before the beginning of the academic year, and will meet four times during the academic year to (1) provide formative feedback on the current design, and (2) develop modifications to improve the functioning of the groups. In the spring of 2017, pod members will participate in surveys and focus group interviews to collect data on this first implementation. Those data will be fed back to the design group, who will meet at the end of spring term 2017 to determine feasibility of expanding pods given the current design and, if not deemed feasible, beginning to design an alternative approach. If deemed feasible, pods will be expanded the following academic year by splitting current pods and recruiting new members. If initial implementation demonstrates feasibility, recruitment of participants and institutionalization of pods will become the focus.

We are currently seeking student co-designers. It is important to incorporate student perspectives very early in our design to ensure that the framing of the problem and bounding assumptions allow for student-centric solutions. Our current focus is defining and communicating the goals and framing of the student pods so that we can purposefully manage the balance between achieving our purpose and allowing significant input from students and other stakeholders.

6. Structural Changes in the Unit

6.1 T*heoretical Framing and Approach*

In order to ensure success and sustainability of the proposed initiatives, changes to long-standing unit policies and procedures will be required. In particular, faculty members who engage in department transformation in formal ways need to be assured that their efforts will be recognized and valued through the approbations and reward structure, including the promotion and tenure process.

CBEE bases review upon employees' *Position Descriptions*. Position Descriptions represent a clear opportunity in our efforts to empower faculty and staff to identify, agree upon, and carry out responsibilities that can be outside of the traditional norms in the academy. Our School will identify *Change Leaders* and formally allot 10% of their effort toward shifting the School's culture to re-situate learning and instruction. More broadly, all faculty will be expected to advance and equalize undergraduate and graduate student success across demographics through communicating clear expectations and holding people accountable to these expectations. This approach places responsibility for culture transformation on each community member as opposed to relying on a dedicated few. Such an approach aligns with recent campus-wide changes at OSU in the expectations for all faculty for promotion and tenure. Specifically, as of June 2015, criteria for promotion and tenure now state that:[34]

> OSU is committed to maintaining and enhancing its collaborative and inclusive community that strives for equity and equal opportunity. All faculty members are responsible for helping to ensure that these goals are achieved. Stipulated contributions to equity, inclusion, and diversity should be clearly identified in the Position Description so that they can be evaluated in promotion and tenure decisions. Such contributions can be part of teaching, advising, research, extension, and/or service. They can be, but do not have to be, part of scholarly work. Outputs and impacts of these faculty members' efforts to promote equity, inclusion, and diversity should be included in promotion and tenure dossiers.

Figure 2 shows contrasting radar plots for a model of how Position Descriptions are currently enacted (Figure 2a) and how we envision change with the RED Project (Figure 2b). Figure 2a shows the distribution of effort for the case of 20 faculty. Each number around the circumference (1-20) represents a faculty member and the blue, red, and grey plots represent to effort allocated to teaching, research, and service reflectively. For example faculty member 1 has 40% teaching, 50% research and 10% service. As they currently exist the allocation of effort is largely prescribed and does not align closely with actual effort. In the revised model, the faculty and the unit head would discuss and agree to position descriptions that aligned with the desired contributions of the faculty member (Figure 2b). The plan gives autonomy to each faculty member and provides value to the many important aspects of faculty work. In this model, the cumulative output of the unit supersedes making each faculty member's responsibility look the same, and, in that way, sends a strong message of the value of inclusivity and diversity.

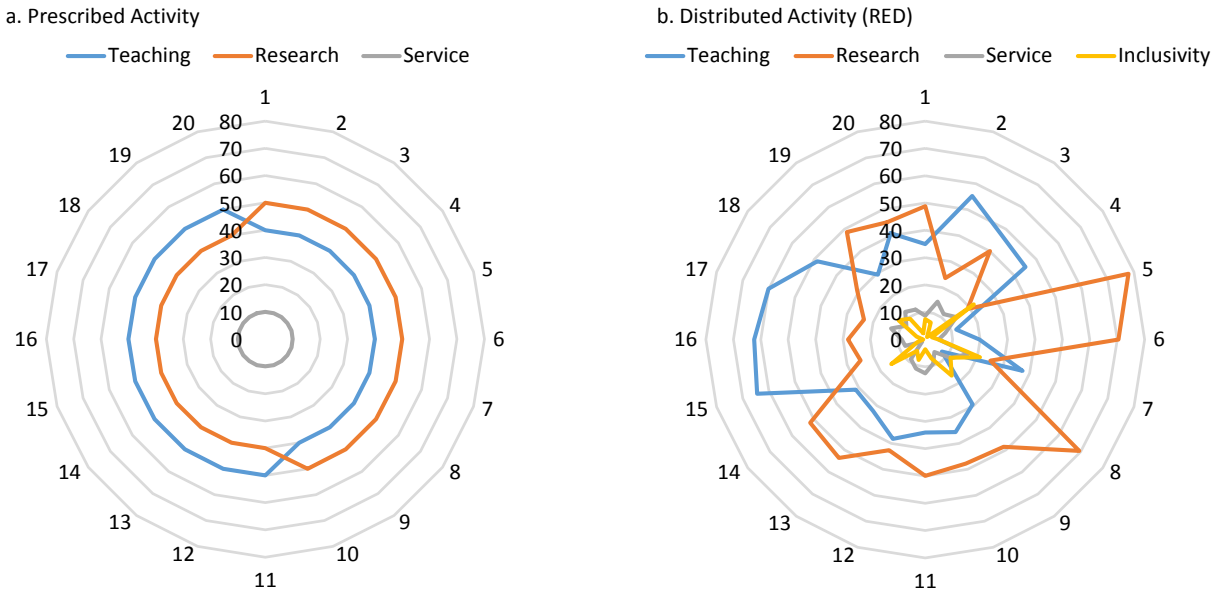

Figure 2. Radar plots of models of percent faculty allocation in position descriptions (a) as presently prescribed to faculty and (b) distributed activity after transformation.

6.2 Progress to-date and looking forward

We sought to initiate the project by providing space for all faculty and staff in CBEE to participate. As a mechanism we used the annual Fall Term Faculty Retreat (an all-day event utilized to initiate each new academic year) as a forum to convey the message that the work and rewards of this project are available for all faculty and staff to participate in, and according to their own interests, expertise, and career trajectories. Subsequent to a brief informational session at the retreat describing the goals and main project activities, breakout groups were formed in alignment with activities described in Sections 3-6 and allowed faculty and staff to discuss one specific activity of potential interest for them. Discussions were audio recorded. Faculty and staff also signed up to express their initial interest in participating in one or more activity areas. All attending faculty and staff expressed interest in at least one project activity, and many listed three or four areas.

We have also engaged our School's Industry Advisory Board (IAB) at our recent fall meeting, not only to inform them on our project efforts, but specifically to enlist their counsel and help in designing and piloting a system for reaching out to alumni and other friends of our programs in industry to create a conduit for working engineers to provide engineering design and analysis solutions that faculty can then dissect and appropriately situate into our sophomore and junior level studio courses as motivational, realistic, and consequential problem sets. Our ultimate vision for this system is of a web portal with annual "call outs" prior to each academic year for ideas and content from which we can develop new studio problems (See Section 3). We also plan to engage our IAB members to interact over time with the newly formed Educational Advisory Board that we have created to provide feedback and advice to us as we move forward with all of our efforts to effect revolutionary change in CBEE, both curricular and co-curricular.

7. Research in RED

Using a design-based implementation research (DBIR) approach,[35,36] ongoing analyses are used to inform ongoing design decisions. In DBIR, implementation "problems" and "successes" provide important information for redesign and elaboration decisions. In a rolling fashion, we will compare data from before RED and from early phases of RED implementation to that from later phases in the following areas: structural changes, climate and inclusiveness, teaching approaches used in core courses, opportunities for students to make sense of a variety of engineering workplaces and their climates in productive ways. In making these comparisons, we will attend to changes in the activity systems involved (OSU, College of Engineering, CBEE) and to the participation and perspectives of faculty, students, and staff. Of particular interest are mechanisms for supporting ongoing work and change after the grant period.

Research activities to date include baseline interviews with 75% of faculty in CBEE and advisors, observational data collection at CBEE faculty meetings, surveys of entering and graduating students, and video recordings of reform and older studio activities. These data are being analyzed and findings will be used in further planning and decision-making. Focus group data with undergraduates interested in the development of Pods and initial planning data have also been collected.

8. Summary

In this paper, we describe a holistic approach for change in which we seek to re-situate learning in CBEE and create an inclusive, professionally-based learning environment woven through both curricular requirements and co-curricular opportunities for students. The approach has four elements: (i) curricular change around realistic, consequential work, (ii) faculty learning about inclusion and diversity; (iii) development of Student Professional Development Pods where students can make meaning of their experiences in a safe place; and (iv) structural changes to for long-term sustainability. We seek to transform the activities systems in CBEE and serve as a model for others as we move towards an innovative and inclusive engineering profession for the 21st Century.

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