Work in progress: Using Community-Based Participatory Design and a Context Canvas to design engineering design courses.

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 Abstract

In a world of open knowledge, engineering students expect from an educational program to provide practical experiences in order to get ready for the job market. Hence, design experiences, as a learning experience, are crucial for student growth, retention and engagement. Therefore, it is important to create innovative learning experiences that satisfy the achievement of these goals. In addition, such experiences need to be feasible for implementation and viable for the designer of learning - the educator. In fact, developing a design learning experience is a design task itself. Educators need to understand the student and the context in which the learning takes place in order to develop an innovative concept of a design activity. The overall purpose of introducing the context in the design endeavor is to create better solutions that suit all stakeholders but more importantly promotes inclusiveness, diversity, and equity in education by putting the student at the center of solution development. Additionally, innovation requires putting together different perspectives and knowledge. Therefore, co-designing with stakeholders is a way to spark this innovation. In this paper, we introduce the Context Canvas as a collaborative design tool to help consider the contextual factors early in the process of design learning experience development. This work in progress paper presents an example of use of the Context Canvas for redesigning a project spine course in the engineering program at our institution.

Keywords: Design experiences, visual tool, context, community-based participatory design, human-centered design, engineering education, problem exploration

Introduction

The necessity to improve education for the benefit of the student continues to increase over time. Some institutions and faculty are now working towards the creation of new or better engineering design experiences for students by considering diversity, equity and inclusion as major issues to address [1]. It is therefore important to understand the system in which learning occurs and acknowledge the environment of the student as being the central "user" or "customer"[1] of the educational service [2]. However, student viewpoints and experiences are often not considered in the design of an engineering design course. Consequently, educators need ways to better understand student perspectives and include their opinions, frustrations and cultures in the design process. Community-based participatory design [3], which posits that designers design *with*

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[1] Our use of the word "customer" does not mean that education is transactional, but rather that many of our students have choices as to where they pursue education and it is up to faculty to design student-centered experiences.

communities rather than *for* communities, provides an interesting lens to better include students in the design of design courses. Community is a social construct defined by identity vectors and shared interests and practices [4]. In this work, we consider students enrolled in the same class and program as a community and faculty as the designers of engineering design courses.

In support of a community-based participatory design process applied to the design of engineering design courses, the Context-centered Canvas tool was developed to empower educators to gather contextual factors that need to be considered in the problem definition phase when designing learning experiences for students[5]. The Context Canvas is meant to provide a holistic representation of influencing elements and help in generating concepts of educational experiences in the ideation phase of the course design process.

The goal of this work in progress is to study the use of a community-based participatory design approach, mediated by a Context Canvas, for the design of engineering design courses. This paper describes the process by which this pilot study will be conducted. The research questions guiding this work are:

1. How do faculty and students perceive the use of Community Based Participatory Design (CBPD) in education contexts?
2. How do faculty approach designing engineering design courses?
3. How do faculty and students experience having a visual guide to mediate the consideration of context in the design of an engineering design course?

In this paper, we first present a background on community-based participatory design and the Context Canvas. We then describe a use case of the Context Canvas, and conclude with future perspectives of the study [7]. The goal of this work in progress paper is to inspire conference participants by presenting a new way of developing design experiences for engineering students. Our intent is to share a different way of approaching learning experience design with the ASEE design community and receive feedback for further improvement as we prepare to conduct this study.

Community-Based Participatory Design and the Context Canvas

Community-Based Participatory Design (CBPD)

Participatory design (PD) is an approach that involves stakeholders in the early stages of the design process. The approach is adopted to ensure that the needs and perspective of "users" are met by involving them in co-creating solutions for themselves with the designers [16]. Designing with stakeholders allows a better understanding of the needs. Indeed, in the process of problem exploration, stakeholders come up with insights from their own experiences which drive towards desirable solutions [17]. In the context of education, *participatory design for learning* is used to create effective educational environments and learning technologies [18]. PD in this case takes a

learner-centered approach to create solutions. As a particular field in participatory design, CBPD is an approach that focuses on and involves the user group that share common aspects such as identity geography, interests and practices. It can serve many purposes such as user understanding, communication and cultural production [6]. It is a design practice that can be organized for, with, or by communities.

CBDP is used in different contexts and settings. In education, the approach is used to help designers make sure they are addressing the needs that students can identify with, and that are in accordance with the culture of the community [17]. In this context, teachers or learning facilitators design together with students. The design approach was used at different levels in literature, from designing a whole class to the development of smaller projects in higher education [19]. The co-creation of learning has many benefits for students and the interest in co-design in education is growing [20]-[21]. For instance, it contributed in building a positive relationship among students and between students and faculty [19]. CBPD is also used as a social action to consider and support underserved and marginalized communities [22]-[23].

 In this work we are approaching the idea of context understanding and consideration from a participatory design perspective and we also structure our research from a CBPD lens.

The Context Canvas (CC)

Considering that designing education cannot be isolated from the environment in which it takes place, the Context Canvas (CC, see Figure 1) [5] as an actionable worksheet was designed to help educators explore the context around classes that are designed. It is a triangulated research tool that enables collecting information on the ecosystem surrounding a course, including the institutional environment, student perspectives, the pedagogical methods appropriate to the topic of the design challenge, the stakeholders motivation and goals (i.e., educators designing the learning experience, students subject of the study, and the institution), and possible constraints from the environment as well as potential hurdles for the designers. The Context Canvas is meant to serve as a guide for context understanding. The goal is to give a holistic view on elements of the context, facilitate connecting the dots, and give rise to new thoughts for solution finding. The tool is meant to help transitioning from the research in the exploration phase of the design process, to the ideation in the solution phase [2]-[5]. This synthesis requires keeping focus on critical criteria for an effective implementation of the solution [1]. Accordingly, the CC helps educators keep sight of relevant elements for developing an optimal solution that considers the feasibility for implementation, the students' voice, and the institution conditions [5]. The worksheet shown in Figure 1 represents specific blocks that guide educators in collecting relevant data from the "user" (student) research. The blocks of the canvas bring structure to the insights and provide a way to analyze collected information. The canvas can be used to either design a new course/learning experience, or redesign an existing one. Further details of the CC are discussed in a previous paper [5].
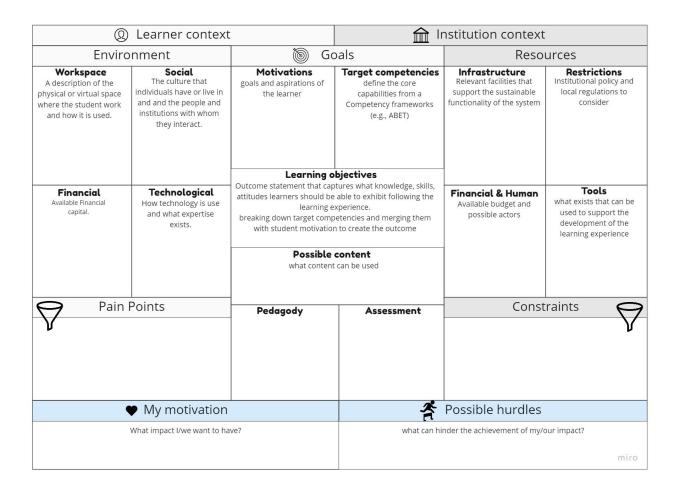
Figure 1. The Context Canvas

Methodology

The goal of this study is to examine the use of a community-based participatory design approach to the design of engineering design courses, mediated by a Context Canvas tool. The research questions therefore focus on both current approaches used by faculty to design engineering design courses, and opinions on using CBPD with the CC for the design of a specific design course. Thematic analysis will be used to answer RQ1 and RQ2, and a case study approach will be used to answer RQ3.

Research Questions

The research questions and sub-questions guiding this study are:
1. How do faculty and students perceive the use of Community Based Participatory Design (CBPD) in education contexts?
   a. What are the advantages and disadvantages of using CBPD in course design?
2. How do faculty approach designing engineering design courses?
   a. How could consideration of context influence the development of design courses?

3. How do faculty experience having a visual guide to mediate the consideration of context in the design of an engineering design course?

<u>Research Context</u>

To conduct the study, we interacted with groups of faculty in engineering education and groups of graduate students in the same field who attended the same workshop during the same period. The students in this case were familiar with design frameworks and had an interest in innovating in engineering education design courses at the freshman through senior levels. Faculty were selected to create a coherent group of similar experiences and fields of interest. As a pilot for the use of CBPD and the CC, participants were invited to redesign a "project spine" (freshman, sophomore, junior, and senior) design course for undergraduate engineering. During a workshop around the Context Canvas, faculty and students formed teams to redesign a project spine course in engineering.

To introduce co-designing and the Context Canvas, teams of graduate students and faculty were invited to participate in a workshop to redesign a project spine course in engineering. This design decision to have a combined team of faculty and students is at the heart of a CBPD approach to course design. Before attending the workshop, participants individually observed different design courses of the undergraduate engineering curriculum to collect data about a current course. They observed class sessions, explored the syllabus of the course and interacted with students and instructors of the course. The observations were documented by each participant. Instructions about what to observe and how to document were not given to not influence participants and allow different observation elements to emerge. The goal was to allow participants to diverge and collect different aspects of the environment without guidance to then use the CC as a way to structure the conversation, the teamwork, and the analysis of the context elements. In the following, we describe the workshop and the process for data collection. The intent of this paper is to encourage innovation seekers to use this tool and share their feedback for the benefit of the design community. For this reason, we are presenting an example of the structure for a workshop along with a way to collect data about the effectiveness of the collaborative context-centered design approach.

The workshop was structured in two parts of 75 minutes each. Participants formed two groups of 4 students and one faculty. Participants were in-person and used a virtual board for collaboration using digital notes. The reason for using a virtual board was to allow the moderator to have a view on the workflow of the two teams simultaneously and to be able to leave comments without interrupting the discussions.

Part 1: Present State of the Design Course

To redesign the project course, participants first described the current state of the courses they observed and then discussed possible future states. The two groups followed the same

structure (e.g., sharing about the current state and discussing future states) but used the Context Canvas in different ways. In the following we present in detail what happened in the two steps for each group.

- Group 1: For the first part of the workshop, Group 1 shared their observations by presenting key insights using their own inductive thematic analysis to structure the elements they collected about the classes. They first started individually and silently adding their notes to the board and then engaged in a discussion about thematics that emerged from the observations by grouping similarities and talking through differences.

- Group 2: In contrast to Group 1, the second group had to use the CC to share information about the current state by filling out the blocks using notes from their observations. The group was asked to a) write down the notes that fits into the canvas, and if needed, create section for remaining notes, then b) fill out remaining sections with what they might know even if that was not documented during the observation, and finally c) mark what needs to be done later in terms of data collection and discuss how they plan to do it. The documentation on the canvas started silently and slowly shifted to a discussion about the blocks that are filled out.

It was intentional to not guide Group 1 in sharing the observations to know what change would happen when the CC is afterwards used to structure the insights by the same group and what themes from the context observation might come out without having a guide for possible themes. The objective is to see how the CC influences collaboration and communication, decision making, perception, and context analysis. Whereas, for Group 2, the purpose for introducing the CC to map the current state was to observe how participants' focus and lenses used for data collection matches (or not) with the elements of the canvas.

The reason for having the two groups use a different approach in describing the current state of the classes is to highlight the impact that the CC would have on the data synthesis and team dynamics. Because participants observed different classes, they had to decide on one class to redesign. The goal from having to choose one class is to trigger decision making and alignment needed for the collaboration. Both groups were asked to highlight what thematics they want to consider for improving the class. For that they had to identify constraints/needs or issues that appeared from the exploration.

Part 2: Future State of the Design Course

In this second part, the groups are required to decide on the constraints that are most relevant to overcome in order to create a better design learning experience for students. Both groups started a discussion about the issues identified from the previous step but the instructions for this part were different for the two groups.

- Group 1: Participants are now introduced to the CC and are asked to compare their previous thematic analysis in part 1 to the themes (blocks) of the canvas. They first started writing down what fits into the canvas from what they have discussed and then explored the other blank blocks. The goal is to encourage the consideration of other elements that might be relevant but were not discussed previously. They are then required to identify new constraints, if any, and prioritize the issues to address for improvement of the design course. The CC is now used as a guide for concept generation and what could be done differently or what to tackle to solve the identified constraints.

- Group 2: the group is now using a new CC to describe the future state of the design course. At this stage, the group is asked to decide on the constraints to focus on and frame a problem statement that describes the identified issue. The statement served as a starting point for using the new CC. The blocks in this case are serving as guides for possible elements to change or to know more about in order to improve the concept of the class or the learning experience.

By the end of the workshop, both teams are expected to describe what could be addressed to improve the design course and have an action plan for what needs to be done after this activity (e.g., conduct more user research, explore the literature, ideate solutions…)

Participants and Sampling

Participants in the survey and workshop were faculty and students in a specific course in the Engineering Education and Design Ph.D. program. In this study, a total of 10 participants took part in the survey and workshop (2 instructors and 8 students). Participants were selected based on purposive sampling. The two instructors who participated were selected based on their experience teaching engineering and design courses at both undergraduate and graduate levels. Participants (students and faculty) were recruited via class announcement. Participation was voluntary. For interviews, participants will be invited to participate remotely (e.g., on Zoom or over the phone), or in-person. Participation in the interviews will be voluntary and monetary compensation will be given to student participants.

Data Collection

Data collection was planned in two steps; before and after the workshops. In the following we describe how the research is conducted with students and faculty. For data collection, different pre-intervention surveys and post-intervention interviews are used for distinct groups (i.e., group of faculty and group of students).

Exploration with Faculty

To collect data from faculty, we had a context awareness survey to assess the understanding and perception of context and learning experience design from faculty. The survey is meant to be

conducted before the workshop and the semi-structured interviews. The goal from the survey is to assess how the perceptions changed after being introduced to the CC in a co-creation format with students. Questions asked in the survey centered on prior course development experiences, followed by perceptions of community based participatory design and context consideration in their work and design practice.

For this workshop, post intervention interviews will be conducted to learn about the co-design experience and understand the influence of the context canvas on the perspective regarding designing learning experiences. Interviews will be reflective in nature, following a semi-structured protocol and taking approximately 30-45 minutes to complete. They will be audio recorded and transcribed. Sample questions are included in Table 1. Questions asked during the post intervention interview are centered on the context canvas experience and how participants used what they had gained in the introductory context workshops and overall reflections on the concept of context consideration and co-creation. Data will be anonymized by giving a pseudonym to each participant.

Table 1. Sample questions from the survey and interview with faculty

Sample questions from the faculty survey ● How do you perceive co-creating a learning experience with students? ● How often have you considered student perspectives when creating a syllabus or curriculum? ● What do you define as important to know when developing a class ?
Sample questions from the faculty interview ● How does it feel to collaborate with students in creating classes? ● How do you perceive exploring the environment in which you teach when creating your class? ● Would adding context into your course support success in student learning? If so, how? If not, why?

Exploration with Students

Same as with faculty, students received a survey before the CC workshops and will be invited to post-intervention interviews. The goal of the survey was to capture the student perspective on how classes are created and what elements are or could be considered in this process. The interview will focus on the co-creation aspect of the workshops with faculty and be a follow up

to the survey answers. The goal is to collect feedback about the experience they went through during the workshops and how the sessions impacted their perspective about co-design. Interviews with students will be reflective in nature, following a semi-structured protocol and taking approximately 30-45 minutes to complete. They will be audio recorded and transcribed. Sample questions of the survey and interview are included in Table 2. Data will be anonymized by giving a pseudonym to each participant.

Table 2. Sample interview from the survey and interview with students

Sample questions from the student survey
- Please indicate what elements you consider as important for you to have a good learning experience?
- Have you ever collaborated with faculty to develop a learning experience? If yes, please indicate your role in this collaboration.
- Please indicate how you feel about sharing your feelings, thoughts, and experiences related to your learning experience with faculty teaching course you are currently taking.

Sample questions from the student interview

- Have you ever felt that your voice is considered when a class is designed?
- How does it feel to collaborate with faculty in creating a course?
- How would you design a design course?

Data Analysis

Given the size of this study sample, results from surveys will be used as a foundation for some follow up interview questions. Interviews will be fully transcribed to develop a data set for further analysis. To answer research questions 1 and 2, thematic analysis will be used to identify key words and patterns based on participants' responses. The key words will be used to create a set of themes and sub-themes related to how students and faculty perceive CPBD, learning experience design, and context consideration.

The third research question will be analyzed using a case study approach since we conducted the research with two separate groups who used the Context Canvas differently [24]. Data from the interviews for the same group will be analyzed together. Yet, each group will be considered as a case study. Answers from participants in each case study (i.e., Group 1 and Group 2) will not be analyzed independently but rather as a group to create themes that reflect the perception of considering the context in the design of an engineering design course. The two case studies will be compared to draw conclusions about the influence of the Context Canvas on the co-design endeavor.

Future Data Collection Contexts

Following the pilot, we aim to collect additional data about the desirability of the Context canvas and the usage of Community-Based Participatory Design in education. For that, two workshops will be conducted, putting together faculty and students in co-design and interactive sessions around the Context Canvas. The workshops are planned for a duration of 120 minutes each. Students and faculty will form groups of 4-5 participants (i.e., two faculty members and three students). For the first workshop, they will be first introduced to the concept of context consideration and then put in two different situations for course development. Some groups will be asked to use the CC in order to rethink a course that the students, participating in the workshop, had in the previous semester. Other groups need to use the CC to create a new course for upcoming semesters. The CC will be used to either explore what exists in the context of the course they are redesigning (i.e., understand the user -student-, the stakeholders, and the surrounding) or understand the setting for a new course. For the second workshop, the same participants will use the data they have collected from previous exploration to generate concepts of the course.

To assess the effectiveness of the CC, observations will be the main data collection source for the workshops. The research team will attend the workshops and capture how participants interact with each other and with the Context Canvas. In this case, the research team will support data collection with ethnographic tools such as the empathy map to better understand the experience of the CC users.

Conclusion and Next Steps

With a purpose of creating better design learning experiences for students in engineering education, this work in progress paper presented a collaborative design approach and tool for educators to use for the development of a design course. The goal was to understand the impact of a participatory design approach in engineering education from both a student and faculty perspective, and discover the advantages and disadvantages of a design tool - the Context Canvas - meant to consider the context in which learning occurs. Results from this study will be used to refine the Context Canvas and help faculty - as designers of education - create collaborative solutions to consider the student voice and overall environment in which education is delivered.

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