WIP: Exploring the Role of Sentiment in Tutor-Student Interaction. The Case Study of CS and Architecture Formative Studio Critiques

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***Abstract*— This work-in-progress research presents a novel approach to assessing tutor-student interactions in design studio critiques, thereby advancing studio assessment methodologies. Following constructivist theories, students learn by practicing professional design behaviors. They introduce new concepts and progress according to the tutor's feedback and demonstration. Despite their principal role, critique interactions are often tutor-centric and ambiguous, resulting in negative sentiments that may hinder participation. Current methods measure solely learners' performance of design practices while neglecting the cognitive actions involved, such as the learner's sentiment. This gap limits assessing the effectiveness of the interaction. In this study, we measure the effect of sentiment on introducing new design concepts, identified as first occurrences (FOs). We demonstrate the approach in two natural case studies comprising six critiques of three CS students and three Architecture students. NLP algorithms are developed to quantify the distribution of FOs generated by students and tutors within positive and negative sentiment environments. Changes in the sentiment throughout critiques measure the temporal role of sentiment in generating FOs. Observations exhibit differences in sentiment between CS and Architecture students. In both courses, more learner-centric FOs occurred in a positive sentiment environment. Using explicit assessment methods opens new possibilities for establishing real-time feedback systems, leading studio-based education to its next step in reshaping constructivist pedagogy.**

Keywords*— *Studio, Student assessment, Sentiment analysis,

I. Introduction

This research presents a data-driven approach to address gaps in current capabilities to assess constructivist learning [1], [2]. It does so by measuring cognitive learning actions involved in tutor-student interactions in formative design studio sessions (termed "critiques", or "crits"), advancing studio assessment methodologies. The proposed measures are explored in crits given in Architecture and Computer Science (CS) studio courses.

Student-tutor interaction in design critiques is the heart of studio education [3]. Studios are becoming increasingly prevalent in CS and Electrical Engineering education [4], [5] using game design as an educational task [6], [7]. Students learn by practicing professional design activities [8]. In this process, students introduce design concepts and progress according to the tutor's formative feedback. Although the approach encourages learner participation [9], crit interaction is often tutor-centric and carries ambiguous feedback, resulting in cognitive actions such as negative sentiments, reduced participation and increased cognitive load that has a negative impact on problem-solving practices and increases dropout rates [10], [11], [12], [13].

Facing these challenges requires more robust methods to assess studio crits. However, current assessment methods lack these capabilities, a gap that has received global recognition [14]. Current methods focus on the quality of learning outcomes [15] or measure solely the learner's generation of design practices [16], [17], [18], [19], thereby neglecting a specification of cognitive actions, such as the learner's sentiment. This assessment gap restricts assessing the educational effectiveness of crit interactions, impeding learning progress.

A. Research Questions

We focus on the role of sentiment in the learner's practice of generating new concepts, assuming that a positive learner sentiment will lead to a change in the frequency of new concepts. The research questions are:

RQ1: How does the sentiment affect the learner's generation of new concepts in design crits?

RQ2: Is there a temporal effect of sentiment on the learner's generation of new concepts?

II. Background

A. Design learning in studio-based education

Design includes a set of practices applied to identify a problem in an existing situation and synthesise a solution to a new and desired one [8]. The process encompasses multiple practices, such as the introduction of new concepts and their development, recognised as 21st-century core skills [20]. Generating new concepts is an essential design practice associated with divergent thinking and design progress [21], [22].

Studio education is the principal setting for educating how to design. Founded on socio-constructivist theories [23], [24], students learn by generating design practices involved in the design process, listening, and imitating the practices generated by their tutors during crits [3]. The tutor's formative feedback given during crits provides the core setting for students to practice and progress through generating new concepts and developing them by both student and tutor [25], [3]. However, since design problems are ill-structured [26], students often experience difficulties in progressing, resulting in increased tutor-based interaction.

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B. Cognitive learning and teaching actions

Different from professional practices, the educational environment involves cognitive actions activated when handling an educational problem. Specifically, we focus on the learner's sentiment, described implicitly as the learning attitude [3], [5] or the tutor's framing of the interaction with participation and attitude [29]. Sentiment is considered influential on cognitive processing [30], [31]. In particular, it is relevant due to the human tendency to "catch" each other's sentiments during a conversation [32]. Sentiment analysis is widely used in higher education to assess teaching feedback, mainly in engineering and technology education and massive online courses [33]. Positive sentiment has a critical function in an educational context for supporting the initiation, growth and maintenance of relationships [32]. It is also relevant for assessing the temporal effect of an educational intervention [34]. However, the effect of sentiment on generating concepts is unknown.

III. Methods

The approach taken in this study proposes to measure the effect of sentiment on the introduction of new design concepts generated in design crits. A synthetic method to measure new concepts identifies the number of "first occurrences" (FOs) in the tokens spoken throughout the crit as a proxy of the appearance of new concepts during the crit. Associated with creative thinking and design progress, FOs are considered to provide an effective assessment method for these design practices [19], [35]. To do so, we apply natural language processing (NLP) in protocol analysis, thereby advancing the traditional analysis methods applied to conversational data [36], [37]. While most models consider each utterance independently [38], our approach considers the interplay of speakers, acknowledging that the sentiment expressed by one entity can influence and be influenced by the sentiment of others. To enable comparisons, the number of FOs is divided by the number of tokens spoken by each participant

A. Case Studies

We demonstrate the approach by exploring two case studies comprising the recorded verbalizations of six crits of three CS students and three Architecture students. The educational task required designing a digital game in CS, and a mixed-use building in Architecture. The transcribed recordings were analysed employing NLP to calculate the distribution of FOs generated by each participant within positive and negative sentiment environments. To track the tutor's framing of a learner-centred interaction, we calculated the ratio of student-tutor FOs within a sentiment environment. A number higher than one reflects a learner-centred interaction. Changes in the sentiment when generating FOs throughout the crits demonstrate the temporal role of sentiment.

IV. Observations

Since this is a small case study, this WIP reports observations that need to be confirmed with a statistically significant sample. The analysis tracked 239 FOs in a total of 4815 tokens for CS crits and 169 FOs in 3490 tokens for Architecture crits.

Observations show differences between CS and Architecture students. Architecture students generated higher FOs/tokens ratios across both positive and negative sentiments compared to CS students, Table I. Architecture students showed variability, with more FOs generated when conveying positive sentiments compared to negative ones. In contrast, CS students exhibit moderate variability, with more FOs/tokens generated in positive interactions compared to negative ones, indicating the role of positive sentiment in supporting ideation.

TABLE I. Student generation of FOs/token in positive and negative sentiment environments

Students	FOs/token	FO/token in positive utterances	FO/token in negative utterances
CS-1	0.67	0.80	0.40
CS-2	0.63	0.72	0.51
CS-3	0.56	0.56	0.56
A-1	0.68	0.74	0.56
A-2	0.76	0.85	0.70
A-3	0.75	0.43	0.60

Figure 1 presents the temporal sentiment values for FOs generated by the students and the tutors within the deciles of each crit. Observations exhibit differences in the sentiment between the tutor and the student, with shifts between positive and negative sentiments measured throughout the crits. Architecture crits exhibit similar behaviour, with a decrease in student positive sentiment during mid-parts of the crits, followed by increased positive sentiment towards the end of the crits. The tutor, on the other hand, showed smaller changes in sentiment, with increased positive sentiment throughout the crits. Similarly, CS students exhibited a decrease in positive sentiment as the crits progressed. However, CS crits show more shifts between positive and negative sentiments for both tutor and students.

Table II presents the ratios of student and tutor FOs within a sentiment environment, reflecting the framing of the interaction. Observations show that CS crits were more student-centric compared to Architecture crits. Despite this difference, similarities are found when calculating FO ratios within the sentiment environments, with more learner-centric FO ratios to be generated within a positive sentiment setting.

TABLE II. Ratios of student-tutor FOs in positive and negative sentiments

Students	Student/Tutor FOs	Student/Tutor FOs in positive utterances	Student/Tutor FOs in negative utterances
CS-1	1.72	2.73	1.03
CS-2	2.10	1.77	2.42
CS-3	0.81	0.45	1.08
A-1	0.38	0.56	0.24
A-2	0.48	0.48	0.47
A-3	0.40	0.43	0.37

V. Discussion

We observed similarities between the disciplines of Architecture and CS, as crit interactions were mainly positive, implying a support for growth [32]. CS crits were found to be more learner-centric compared to the tutor-centric architecture crits. Learner-centredness was found in positive sentiment in both disciplines, serving as a preliminary insight for the

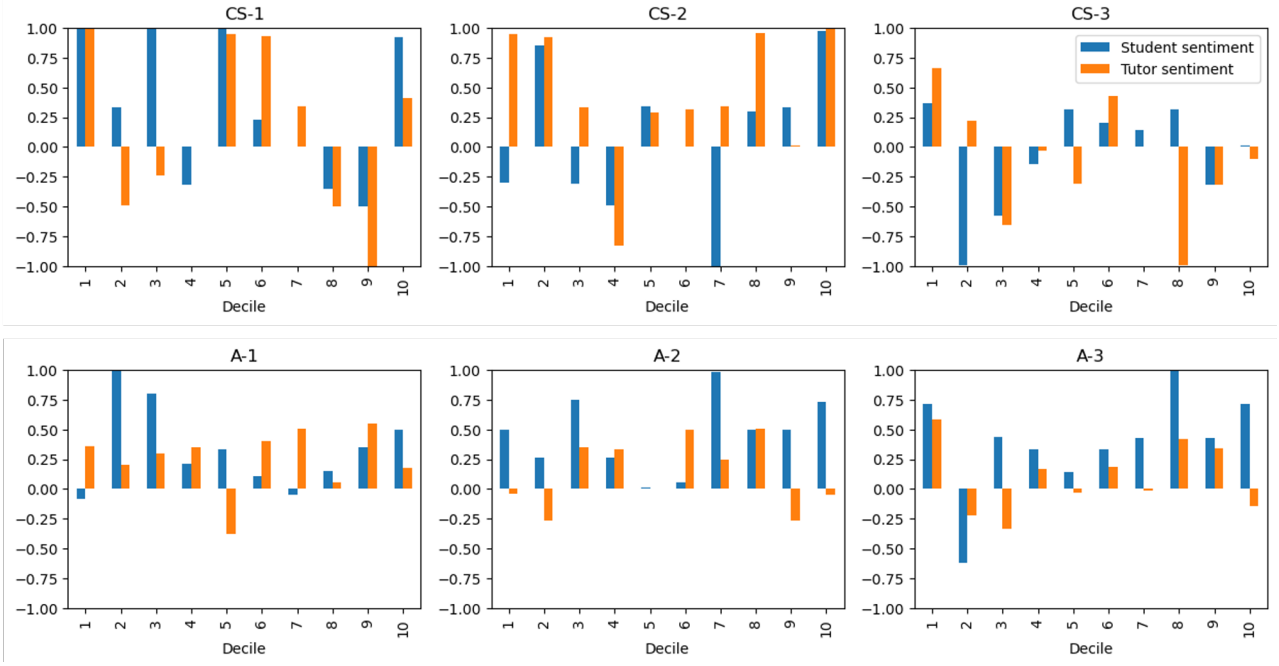

Fig 1. Sentiment for FOs generated by the students and the tutor throughout CS crits (top) and Architecture crits (bottom)

sentiment's role in supporting learner-centric interaction, considered important in constructivist learning and progress [9]. This tutor-centredness, along with the temporal changes and shifts in sentiment throughout the crit time, expand previous understandings of the interaction during design crits [10], [11], [12], [13], [39].

VI. Conclusions

This WIP research explored the effect of sentiment on generating FOs during design crits. The small sample size of the two case studies limits generalised conclusions. In addition, we faced difficulty in determining the sentiment value for short utterances. Nonetheless, this study demonstrates how tutor-student interactions can be measured, employing NLP to offer explicit assessment to support progress. Furthermore, the nuanced understanding of conversational sentiment analysis elevates the methodology beyond traditional sentiment categorisation, offering a detailed representation of the crits' cognitive landscape. Future research steps will develop the technique to assess the sentiment in the context of the tutor-student conversations and employ the method with a statistically significant sample. Using explicit measures to assess crit interactions opens new and unexplored possibilities for establishing real-time and predictive feedback systems in design pedagogy, leading studio-based education to its next step in reshaping constructivist pedagogy.

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