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Critically Examining Constructive Alignment for Marginalization: An Analysis of Foundational Works and Modern Applications in Engineering Education

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Abstract

Constructive alignment is a promising and popular pedagogical tool, resulting in considerable improvements in learning for relatively little instructor effort compared to other pedagogies. Its use is extensive and it has promising implications for improving engineering education, but the original model of constructive alignment does not consider marginalization or related issues such as sexism or racism. Therefore, constructive alignment may have the potential to preserve and propagate the mechanisms of marginalization, and it is critical to examine this concept and its applications for the potential to preserve and strengthen marginalizing processes.

The research question is, is there potential for marginalizing biases to be present in the concept of constructive alignment and its applications? This paper presents a critical examination of select literature on constructive alignment. The foundational works of Biggs and Cohen in developing constructive alignment are evaluated for marginalizing concepts and processes, as well as the widely-cited update to the model presented by Biggs, Tang and Kennedy. The results of a structured literature review on constructive alignment and marginalization are then presented, and the findings are discussed.

The paper concludes that, while marginalization is not explicitly encoded into the concept of constructive alignment, considerations of issues such as sexism, racism, privilege, and oppression are largely absent from the major works popularizing the concept. A subsequent literature review shows these considerations have largely, although not entirely, been excluded from subsequent applications of constructive alignment, allowing for reification of discriminatory educational practices. Compared to the large body of literature on constructive alignment, there is very little work on the interaction of constructive alignment with marginalization. The case of the technology gap is identified as an explicit example of how marginalization can erode the efficacy of constructively aligned education, results in inequitable student outcomes. Constructive alignment is a fundamentally subjective and qualitative pedagogy that heavily relies on the skills and professionalism of practitioners for its success, and the absence of explicit guidelines on marginalization opens the door for potential biases and discriminating attitudes of facilitators to negatively affect the education of equity-deserving engineering students. The absence of such guidelines is especially critical in engineering education, a fundamentally social profession that holds safeguarding public welfare as its highest principle, and may interact with the phenomenon of the technology gap to produce marginalization in the highly technology-dependent discipline of engineering education. Therefore, there is a need for an evaluation of how extensive the impact of marginalization on applications of constructive alignment has been, and subsequently the development of an updated model of constructive alignment that addresses issues of marginalization.

1. Introduction

Constructive alignment is the pedagogical concept that students learn better when the learning outcomes, learning activities, and assessments in an educational offering are designed holistically

to support one another and allow students to demonstrate their understanding as directly as possible [1]. Introduced by Biggs in 1996 [1], a constructively aligned course clearly states learning outcomes that can be directly demonstrated by students and observed by instructors, and learning activities and assessments directly align with these outcomes. Constructive alignment is a popular concept, promising considerable improvements in student learning for relatively little effort on the part of the instructor [2], improving graduation rates [3] and decreasing course failure rates [4]. The concept bridges the gap between what instructors intend students to learn and the methods used to accomplish this learning [1] and holds promise to improve engineering education [5].

The predecessor of constructive alignment, instructional alignment, was developed in the 1980's by Cohen [2]. Instructional alignment introduces the core aspect of constructive alignment, that learning outcomes, activities, and assessments should be aligned and support one another. Biggs' development was to pair instructional alignment with a strong focus on the role of student activities in creating meaning, which he identified as the common core of constructivist learning theories [1]. Biggs has periodically published updates of the model of constructive alignment in "Teaching for Quality Learning at University", starting in 1999 and with the most recent 5th edition published in 2022 [6].

Since the 1970's, engineering education and the professional engineering field have become increasingly diverse [7]. However, despite decades of concerted institutional efforts, parity in the field across diverse identities such as race, gender, and sexuality has not been achieved, and marginalization remains an entrenched issue in engineering education to this day [8]. There is a deep and wide-ranging desire to make engineering more equitable, diverse and inclusive [9], and the pedagogies used in engineering education directly affect progress towards these goals. It is important to note that this cultural context means it is not enough for a pedagogy to simply not demonstrate marginalization; marginalizing behaviours such as racism must be actively combated, otherwise they can continue unabated or may even be strengthened [10].

With its hallmark of centring the learner's activities in creating meaning [1], constructive alignment appears to align with efforts to reduce marginalization in the field of engineering education [9]. However, despite its popularity, there appears to be little research on how constructive alignment interacts with processes and instances of marginalization, with the literature review presented in this paper finding only two works explicitly considering marginalization in constructive alignment out of tens of thousands of papers on the development and use of the pedagogical concept.

Marginalization is a cultural phenomenon that is perpetrated more through structural mechanisms than individual instances of discrimination [11]. Both constructive alignment and its preceding concept of instructional alignment were developed within the marginalizing culture of the 1980's and 1990's, decades marked by homophobia and heterosexism with discrimination of gay and bisexual men in the AIDS epidemic [12] and the American military's "don't ask, don't tell" policy [13], racial disparities in educational outcomes [14], and continued misogyny in both engineering education [15] and practice [16]. The interpretivist research paradigm states that knowledge cannot be separated from the context it was developed in [17], and constructive alignment therefore risks inheriting and propagating marginalizing elements of the culture it emerged from. The development of constructive alignment within this marginalizing culture

raises a critical question: Will the use of constructive alignment in university engineering education limit the success of the next generation of engineers? The original works on constructive alignment and modern applications of the concept must be critically examined in the context of marginalization.

The research question is, is there potential for marginalizing biases to be present in the concept of constructive alignment and its applications? This paper presents a critical examination of the foundational works and some modern applications of constructive alignment in the context of marginalization, taking the first steps in closing this literature gap.

2. Methodology

To answer the research question, "Is there potential for marginalizing biases to be present in the concept of constructive alignment and its applications?", this paper presents a critical examination of select literature on constructive alignment; an expanded systematic literature review is identified as future work. An interpretivist theoretical framework is used [17], examining literature in terms of the subjective and interpretive stances practitioners of constructive alignment may take.

The review starts with the works of Biggs [1], who first developed constructive alignment in 1996, and Cohen [2], who popularized the concept's theoretical forerunner, instructional alignment, in 1987. These papers form the research foundation for constructive alignment and are analyzed to see the role that marginalization played in constructive alignment during the concept's development. Cohen's paper on constructive alignment [2] also contains numerous references to preceding studies on instructional alignment. Within the review of Cohen's paper, these references are subjected to the same word search explained below to identify any connections to marginalization.

While Biggs' seminal work still sees significant citations, he has updated the concept in the multiple editions of "Teaching for Quality Learning at University", with the most recent 5th edition published in 2022 [6]. This work is also included in this research.

Following the examination of critical pieces of research on constructive alignment, a literature review on marginalization and constructive alignment was conducted. The Google Scholar search engine was used with the search terms "constructive alignment" and "marginalization". The search was conducted on February 10th, 2025 and returned 213 results; the date is included to contextualize the review, as the number of results is expected to change over time. The search was limited to conference papers, journal publications, and books, and only included works that have been cited at least once; as well, articles requiring paid access or that were non-English and did not have an English translation were excluded. It should be noted that some paid access articles were accessible for free through institutional licenses and are therefore included. Literature was only included if it had been cited at least once, indicating that it has influenced or incited further research. After incorporating these restrictions, 51 pieces of literature remained.

For all reviewed literature, including the originating works on constructive alignment, the abstracts were first read through to identify if any connections to marginalization or the absence thereof were a primary focus of the paper; the only exception is books, which typically do not

have abstracts. The papers were then subjected to a word search to see if terms relating to marginalization and equity, diversity and inclusion were included. The full list of terms searched is “marginalize / marginalized / marginalization”, “equity”, “diversity / diverse”, “inclusion”, “equal opportunity / opportunities”, “underrepresentation”, “disadvantaged / disadvantage”, “sex”, “race”, “ethnicity”, “sexuality”, and “gender”. The goal of this search is to identify if there are any works on constructive alignment that explicitly and critically examine the concept itself in relation to marginalization; literature that contained mentions of both constructive alignment and marginalization, but did not discuss them in tandem, do not align with this goal. For example, one reviewed paper [18] discusses the use of constructive alignment in developing a university program for care workers in learning disability services. While this discussion connects constructive alignment and care work in learning disability services, an area with a strong connection to marginalization, it is only when the article explicitly critiques constructive alignment for not including a situational learning model accounting for students’ cultural contexts and considerations of gender and ethnicity that it meets the goal of this paper.

3. Critical Examination of Constructive Alignment Literature

The originating and critical works on constructive alignment are examined in the first section, selected as the original and updated literature on constructive alignment that still sees extensive citations to this day. The following section presents the results of the literature review on marginalization and constructive alignment. Each section examines the literature before discussing it in reference to marginalization. Papers are reviewed in chronological order to track the evolution of constructive alignment from its creation to its modern usage in engineering education.

3.1 Originating and Critical Works in Constructive Alignment

The review begins with Cohen [2], who popularized the construct of instructional alignment that preceded constructive alignment and is extensively referenced by Biggs [1] in the creation of constructive alignment. Biggs’ originating paper is then reviewed. A brief review of Biggs’ updated model of constructive alignment is also presented [6].

“Instructional alignment: Searching for a magic bullet,” S.A. Cohen, 1987 [2]

In Biggs’ original article on constructive alignment, instructional alignment was cited as a key construct informing the development of constructive alignment [1]. It is important to analyze this concept in the context of marginalization, as marginalizing biases and structures present in instructional alignment may have been incorporated into constructive alignment.

Instructional alignment is the concept that students learn better when conditions are aligned between their learning activities and their assessments [2]. Cohen opened the article by reviewing past work on instructional alignment as well as mastery learning, the concept’s overarching theory of learning. Cohen then introduced more contemporary articles demonstrating instructional alignment’s effectiveness in improving student learning. They closed by detailing the implications of these works for educators and researchers.

There is limited mention of marginalization or related terms in Cohen’s paper [2]. None of the terms listed in the Methodology section were found, with the exception of “disadvantaged”; this

term appears in reference to past work on instructional alignment, mentioning that "the results of other behaviourists' task analyses caught the rising tide of federal funds targeting the disadvantaged" [2, p. 17]. However, Cohen did not go into detail on what exactly is meant by "disadvantaged" students, and demographic variables are not discussed at any point in relation to the effectiveness of instructional alignment.

The literature referenced by Cohen [2] was also examined to see if preceding research on instructional alignment considered marginalization, of which there were some mentions or examples in the text. When looking at the development of the DISTAR learning system, Cohen noted that "disadvantaged children" were included in the study population, but the demographic detail in the DISTAR paper itself was limited and only described them as students with learning disabilities [19]. Cohen referenced another article studying the effect of varying word formulation of math problems on the academic performance of grade school students. The authors of that paper described the study population for their first experiment as "thirty-five gifted sixth- and eighth-grade students, white and Asian, middle class, with an IQ of 132 or above, of whom half were only average… in math achievement" [20, p. 180], but gender was the only demographic variable included in the analysis, and the student populations of the other experiments were not described in the same level of demographic detail. This phenomenon occurs in several other studies cited in Cohen's article, where demographic variables were collected or mentioned but were not included as a variable in analyzing data [21, 22, 23, 24].

Overall, a review of Cohen's article and his cited sources revealed a lack of discussion of marginalization in developing the concept of instructional alignment. Collected demographic data was quite limited, even in cases where they would be directly relevant to the research question. For example, Cohen specifically cited a 1986 study [24], describing its population as "low socioeconomic level, urban, low achieving fourth graders" [2, p. 18]. This would seem an ideal study in which to analyze the relationship of student demographics to success in an instructionally aligned program, but student demographics were not used as a factor in data analysis. Given that Cohen touted instructional alignment as achieving large impacts on student learning for comparatively little instructor effort, it is vital that marginalization be considered in the application of instructional alignment, lest its use further marginalize equity-deserving students.

A closing note on Cohen's work is a quote that highlights the notable absence of marginalization in the construct of instructional alignment. Given the large effect size of instructional alignment, Cohen concluded that a "lack of excellence in American schools is not caused by ineffective teaching, but mostly by misaligning what teachers teach, what they intend to teach, and what they assess as having been taught" [2, p. 19]. While instructional misalignment may certainly have a negative impact on the quality of the American education system, there is extensive evidence on the negative impact of long-standing marginalizing processes and systems within both the American [25, 26] and Canadian [27, 28] education systems, both in general and for engineering specifically; the exclusion of such critical issues highlights the absence of marginalization in instructional alignment at this point in time, which may carry forward to works using Cohen as a reference.

"Enhancing teaching through constructive alignment," John Biggs, 1996 [1]

Constructive alignment was first developed by researcher John Biggs [1]. The paper remains popular to this day and is a common reference for the use of constructive alignment; therefore, this paper is a crucial inclusion when examining constructive alignment.

Constructive alignment combines two theoretical concepts. First, this pedagogy uses the concept of instructional alignment popularized by S.A. Cohen [2] in mastery learning, dictating that students learn better when stimulus conditions are aligned between the learning goals, learning activities, and assessment. However, Biggs found instructional alignment to be insufficient and critiqued mastery learning as "support[ing] narrow, low level cognitive goals… there is no evidence that mastery learning is of value to those interested in achieving broader outcomes" [2, p. 350].

To rectify these perceived shortcomings and achieve higher-order cognitive goals, Biggs introduced a second key theoretical concept of constructivism. Specifically, Biggs used what they described as the common theme of constructivist learning theories, "the centrality of the learner's activities in creating meaning" [2, p. 347]. The introduction of constructivism centred teaching and learning activities on the student. Constructive alignment can therefore be seen as an expansion of the concept of instructional alignment, with the primary points of difference being that constructively aligned educational offerings include clear statements of the learning goals by instructors, and that activities are explicitly designed to encourage student displays of behaviours indicating understanding of the educational material and accomplishment of the learning goals.

Moving to a marginalization-based critique of constructive alignment, a positive takeaway is that Biggs' paper [1] did not include explicit or overt instances of discrimination, or contain it within its technical language, both of which are common features of educational environments "chilly" towards under-represented minorities [11]. However, the paper did not contain any references to the search terms listed in the Methodology section. As constructive alignment was developed in a culture with systemic processes of marginalization, it can potentially carry the same cultural hallmarks and systems within itself.

Examining marginalization is especially important in the context of constructive alignment because the implementation of this instructional pedagogy is highly dependent on the personal subjective judgement of the instructor. Constructive alignment requires choosing activities that will elicit student responses demonstrative of the understanding the instructor is looking for. Biggs noted that eliciting these appropriate behaviours "depends on the group size, and the competence of the tutor" [1, p. 354]; variation in students, such as socioeconomic status, educational history, or racial, gender, or sexual identity were not considered. This element of instructor judgement was also present in Biggs' discussion of assessment choice: "In deciding the assessment tasks, it is necessary to judge the extent to which they embody the target performances of understanding, and how well they lend themselves to evaluating individual student performances" [1, p. 356]. It is known that aspects of student identity have significant effects on academic performance [11], but their absence from constructive alignment means that educators have not been provided guidance on how to implement constructive alignment in a

way that equitably benefits all students and ensures inclusion of a diverse range of student backgrounds.

Biggs [1] mentioned that teaching and learning activities do not need to be the sole domain of traditional instructor-led lectures; peer groups and independent learning are also viable avenues of activities in a constructively aligned course. However, both forms of learning carry their own marginalization-related pitfalls. Peer groups carry the possibility of bias and marginalization [11], with under-represented students potentially facing discrimination from their classmates. Independent learning can also unfairly penalize students with a lower socioeconomic status, as the cost of university means these students often need to work part-time jobs and therefore can lack sufficient time for effective independent learning [11]. There is a need for guidance on constructively aligning both critical learning activities for addressing marginalization.

"Teaching for Quality Learning at University," 5th ed., Biggs et. al., 2022 [6]

Following the seminal paper on constructive alignment [1], an updated model of constructive alignment was published as the "Teaching for Quality Learning at University" book in 1999, expanding on and providing steps to implement constructive alignment in university courses. The most recent 5th edition was published in 2022 [6] and has over 27,000 Google Scholar citations at time of writing, indicating extensive use in research and education; this 5th edition is briefly reviewed here.

A full version of the book [6] was unavailable at the time of writing; however, a preview of the first 128 pages, a search function encompassing the entire document, and the tables of contents, figures, tasks and boxes were available and are used for this review.

The 5th edition includes a foreword, preface, and a list of the outcomes the authors expect readers to achieve [6]. Examining these provides more detail on how the book expands from Biggs' original model [6] and potential interconnections with issues of marginalization; the results of the key terms search are presented as relevant to identify if these potential connections or lack thereof are realized in the main body of the book.

The foreword states that there have been "major changes since the fourth [previous] edition in 2011: participation rates have bloomed, diversity has blossomed and new technologies are now the norm" [6, p. xiv]. This quote explicitly connects the growing student diversity in higher education to a need for an updated model of constructive alignment, mirroring the impetus for this current study. However, the remainder of the foreword does not explain how considerations of student diversity have been incorporated into constructive alignment.

Diversity is touched on again in the preface: "the mix of students now enrolling at university is more diverse" [6, p. xvii]. However, the impact on constructive alignment is not explained, and the authors explicitly exclude such considerations in a following paragraph responding to reviewer comments and suggestions: "We have accommodated many of these [comments and suggestions] where we could, but not all. For example, we were asked to address such matters as students' ages and ethnicities, their personal development, their levels of literacy and numeracy, even to address specific learning disabilities. These are important issues, especially now that over 60 per cent of school leavers comprise the intake into university, and when, as in Australia,

universities are forced to rely on international students as a major source of their income. However, in the space available here, our focus must remain on the design of teaching and learning as a *system*, not on the student as a 'person'" [6, p. xvii]. This lack of consideration of student diversity indicates that the updated model of constructive alignment will also not contain such considerations. This exclusion appears odd given the authors' statement that universities are increasingly relying on international students as an income source, who will necessarily have a more diverse background than a student body composed solely of domestic students. The focus on the teaching and learning system also conflicts with a later statement that "the focus should be shifted from the teacher to the learner" [6, p. 11] to improve teaching.

The preface goes on to say, "…constructive alignment as a design for teaching is a great deal more flexible than other designs, and through reflective practice, and with the help of the writing of others on these matters, teachers can adjust teaching and assessment to allow for such differences in their own contexts" [6, p. xvii]. This quote shifts the responsibility for consideration of how to accommodate student diversity from the model of constructive alignment to the practitioner's implementation of it; as well, positioning student diversity as "something to accommodate" presents a homogeneous student body as the norm and implies that any variations from this norm are the responsibility of teachers to accommodate. However, placing the responsibility for such considerations on the teacher and informal support mechanisms like reflection and reading relevant literature seems to conflict with a later quote from the preface, stating "the responsibility for teaching lies not on how well individual teachers perform but on the departmental and institutional infrastructure" [6, p. xviii]; it should also be noted that, while the lists of contents, figures, tasks, tables and boxes include some references to reflection and provide guidance on reflective practice, a word search shows that reflective practice does not appear to be paired with considerations of diversity in the book. If teaching responsibility is dependent on broader structural mechanisms outside of the individual classroom, mechanisms which may encapsulate or perpetuate marginalizing structures or processes, then teaching practice would certainly benefit from a model of constructive alignment that explicitly includes considerations of marginalization. The authors also acknowledge that, for university professors who both teach and conduct research, "developing teaching expertise usually takes second place [compared to research activities]" [6, p. xviii]. Given this de-prioritization of teaching expertise in contemporary universities, the authors' earlier statement that instructors can develop their practice to accommodate for diversity appears contradictory, requiring time and effort in an area that the authors admit is a secondary concern for most university instructors.

Considerations of diversity and marginalization do not appear in the remaining front materials for the book [6]. No such considerations are present in the list of outcomes the authors intend readers to achieve or in the lists of tables, figures, tasks, or boxes. A review of the table of contents reveals no explicit considerations of diversity or marginalization, in line with the authors' stated position in the preface and foreword, but the following chapters may contain such considerations: "1 - The evolving context of university teaching", "2 – Teaching according to how students learn", and "4 – Contexts for effective teaching and learning". All three chapters consider contextual factors in university learning, a context which includes diversity and marginalized backgrounds; the first chapter is included in the available preview in its entirety and is therefore reviewed below, but only partial sections of chapters 2 and 4 were available and therefore could not be reviewed.

Chapter 1 mentions several times that university participation has greatly expanded in the 21st century and devotes a section to the effect of increased student participation and diversity in the university learning context. The authors state, “Within the same university, the range of abilities, motivations and expectations within classes is now considerable, which presents teaching-related problems to staff” [6, p. 5]. The authors then identify two primary sources of this diversity: the worldwide increase in international students and the changing academic orientation and commitment of students. These discussions do not mention student demographics or marginalizing structures in universities that may affect these students. The final part of the chapter relevant to this review is the recommended further readings, which include a 2007 article on dealing with diversity; however, this is not part of the main body of the chapter and therefore may be less focused on by readers.

A search for the key terms defined in the Methodology section does not return any relevant results [6]. “Marginalize / marginalized / marginalization” only appeared in descriptions of marginal grades, indicating students who did not satisfactorily meet expectations. “Equity” appears twice, once in the description of a further reading on diversity recommended at the end of Chapter 1 and again in Chapter 14 in reference to an example of learning outcomes. “Diversity” is the most-mentioned term with 25 instances, but the majority of these are either in the already-reviewed preface, foreword, and Chapter 1, or are in reference lists. The one exception is the quote that “diversity is excellent, as it shows that there is no one way of implementing CA [constructive alignment]” [6, p. 316]; again, there is no corresponding explanation of how to implement constructive alignment in these diverse contexts. “Disadvantage / disadvantaged” appears several times but only refers to how misalignment can generally disadvantage learning, not disadvantage resulting from marginalization. Finally, the demographic key terms do not appear in any relevant sections of the text; “race” only appears in an author’s name, “sexuality” only appears in two references to sexual harassment, and the other demographic terms do not appear.

To summarize, considerations of diversity and marginalization do not appear in the updated model of constructive alignment, and are explicitly excluded, with the authors positioning the focus of constructive alignment on the teaching and learning system rather than individual learner characteristics [6]. Given the authors’ acknowledgement that increasing student diversity poses new teaching challenges in university education, and that the responsibility for teaching lies more with the departmental and institutional structures around classrooms rather than individual instructors, including considerations of marginalization and diversity would be a worthwhile addition to the model of constructive alignment.

3.2 Literature Review of Constructive Alignment and Marginalization

The literature review found a total of 51 works when using the restrictions described in the Methodology section. After conducting searches for the key terms described previously, two papers were found that explicitly discuss how marginalization may interact with constructive alignment.

Before discussing the reviewed papers, the number of citations in the reviewed works should be noted. The two papers found that explicitly discuss marginalization in constructive alignment have 3 and 17 citations in Google Scholar, respectively [18, 29]. The highest-cited work was

Biggs et. al.'s "Teaching for Quality Learning at University" [6] with 27,278 Google Scholar citations. The comparatively low number of citations for works discussing marginalization in constructive alignment potentially indicates, but does not prove, that the majority of applications of constructive alignment do not consider the potential for marginalization to be embedded within constructive alignment itself, leaving room for marginalizing biases to recur in these applications.

The first article discussing marginalization in constructive alignment is "Empowering learners: an exploration of mediating learning for care workers" [18]. This article examines the impact of a university Certificate in Empowering Practice for care workers in learning disability services, specifically examining lecturers' perceptions of the teaching and learning processes intrinsic in successfully obtaining the certificate. The article reviews the underlying methodology used in developing the certificate, including constructive alignment.

In discussing constructive alignment, the authors [18] state that the Certificate in Empowering Practice exemplifies constructive alignment, showing the improvements in learning when activities are aligned with outcomes; however, the authors include the caveat that they were working with motivated students whose personal experience was relevant to the program goals, implying that constructive alignment may not produce such improvements in learning if learners are less motivated or have less relevant personal experience. This is an important note on how constructive alignment may have varying outcomes for students from different backgrounds, highlighting the potential influence that marginalized backgrounds may have on academic success in constructively aligned programs.

The authors [18] also critique constructive alignment for not including a situational model of learning. The authors identify cultural context as a key factor influencing student success in the situational model of learning, and see the inclusion of such a model in constructive alignment as "leading educators to ask: … who are these people [students] and how will they best learn? It asks you to take a situational analysis of individuals within your group in terms of their experience of learning, their social class, their gender, their ethnicity and the ratios around the large group of those different groups" [18, p. 189-190]. The consideration of factors like social class, gender, ethnicity, and representation thereof in university learning is an explicit connection between the concept of constructive alignment and consideration of marginalization, showing that these authors perceive constructive alignment to be lacking in such considerations; specifically, that constructive alignment does not sufficiently consider the backgrounds and cultural contexts of students. It is important to note that this is a critique of constructive alignment as a pedagogical concept and is not limited to the specific application of constructive alignment explored by the authors. As well, while the authors do identify a need for combining a situational model of learning with constructive alignment to address student cultural contexts and marginalized backgrounds, they do not develop such a model within the paper, and a follow-up paper developing this model has not yet appeared within the literature review.

The next paper relating marginalization and constructive alignment is "Specifying a curriculum for biopolitical critical literacy in science teacher education: exploring roles for science fiction," an essay journal paper proposing ways for Western science teachers to facilitate students' critical literacy in biopolitics [29]. Gough dedicates a section of the paper to examining curriculum design with a close focus on constructive alignment, critiquing the concept as inherently

oppressive. Gough argues that constructive alignment is simply a reincarnation of early twentieth century Anglophone and US-centric curriculum development literature principles of 'scientific management'. Gough states that "constructive alignment, like the curriculum development models that precede it, presumes that curriculum components, such as intended learning outcomes, learning/teaching activities, and assessment tasks interact as elements of a simple system" [29, p. 771]. Gough asserts that real teaching and learning is a complex system that cannot be reduced to simple terms, and that this simplistic characterization depicts curriculum gaps as systemic curricular flaws rather than sites of emergence offering learning opportunities. The author identifies the majority of courses in his local context, an Australian university, as being developed with the use of constructive alignment and proposes tactics of deconstructive non-alignment, elaborated on in another paper [30]. Overall, while constructive alignment is explicitly connected with oppression in this paper [29], the myriad marginalizing forms oppression may take are not examined in relation to this pedagogical concept. This examination is also absent from the paper on deconstructive non-alignment referenced by the author [30].

To conclude the literature review, the initial 213 pieces of literature were winnowed down to 51 when limited to non-paid-access journal articles, conference papers, and books, which had at least one citation and were either written in English or had an English-language version accessible. When examining these works, only two were found that explicitly discuss marginalization or related considerations and their potential interactions with constructive alignment. Neither article presents a deeper exploration of these interactions, such as considering specific demographic characteristics or forms of marginalization, and do not extend their critique to proposing an improved model of constructive alignment. It is therefore concluded that marginalization-based critiques and an improved model of constructive alignment considering marginalization are largely absent from the literature.

4. Discussion

The risk of strengthening marginalization with constructive alignment is a key motivator of this work. The author previously investigated how to improve materials science laboratories through established educational scholarship and found that constructive alignment was a promising avenue for improvements [5]. However, a critical weakness of this work was that demographic information was not collected, preventing the analysis of whether educational outcomes were affected by students' personal traits. Such data can help in transforming inequitable conditions and addressing marginalization [31].

Marginalization appears to be largely absent from the development and use of constructive alignment. The original model of constructive alignment [1] does not contain any considerations of the variety of students' personal traits, including socioeconomic status, educational history, racial identity, gender, or sexual orientation; such considerations are also absent from the updated model of constructive alignment published in 2022, with the authors stating that "our focus must remain on the design of teaching and learning as a *system*, not on the student as a 'person'" [6, p. xvii]. This absence of marginalization extends to both the works preceding the creation of constructive alignment [2] and its modern applications, with a literature review of constructive alignment and marginalization only returning two results explicitly discussing marginalizing potentials in constructive alignment [18, 29]. These works also have only 3 and 17 Google Scholar citations, respectively, compared to the updated model of constructive alignment [6]

which has over 27,000 at time of writing. This relative paucity of literature on marginalization in constructive alignment, compared to the large body of work on the pedagogical concept itself, reinforces the perception that considerations of whether marginalization may be present in constructive alignment have been largely absent from research on and applications of constructive alignment.

The absence of marginalization is particularly notable given that many pieces of reviewed literature examine issues directly relating to marginalization but do not examine them further in relation to marginalization. Both the original [1] and updated [6] models of constructive alignment exclude these considerations as well, despite the authors' statement in the latter publication that growing student diversity poses teaching challenges in contemporary universities.

It is known that students' personal traits interact with a cultural system of marginalization to affect academic performance [11]; given the absence of consideration of these elements in developing constructive alignment, the concept can potentially strengthen marginalizing processes when implemented without regard to critical aspects of students' identities. Furthermore, students' traits change with time; the Baby Boomer, Generation X, Millennial, and Generation Z generations all have unique needs, strengths and weaknesses when interacting with educational systems that have changed with societal and technological change [32]. This is explicitly addressed in one of the reviewed pieces of literature, with a 2005 paper stating that constructive alignment is weakened by the absence of a situational model of learning that accounts for the contexts and backgrounds students enter university from [18]. If constructive alignment does not encapsulate diverse perspectives, it will retain the societal mores of the culture in which it was developed and will not address students' changing needs and personal traits. Consideration of students' personal traits is especially important given constructive alignment's dependence on instructors' subjective judgements, with educators having to decide what student behaviours are indicative of understanding and choose activities expected to elicit these behaviours [1]. Both choices are culturally influenced and may replicate instructors' personal biases, reifying marginalization within constructively aligned courses.

A potential example of this marginalization is the phenomenon of the technology gap, wherein lower socioeconomic status students have a lower level of access to computer technology than their higher-status peers [33]. Education programs that use computer technology therefore have the potential to marginalize lower socioeconomic status students who face more barriers to using technology and therefore do not develop their skills to the same degree as students with better access. An instructor choosing a display of computer skills as evidence of student understanding in their constructively aligned course could unfairly penalize students from lower socioeconomic status backgrounds. This has significant consequences for engineering education given the widespread use of technology in throughout the field's history [34].

A similar event occurred in the author's local engineering education context: a first-year engineering course at the University of Calgary originally included activities that required students to manipulate data in Microsoft Excel and generate graphs. It was developed based on the assumption that all students would have previously used Excel in high school, but a significant proportion of the students were found to have never used Excel before, requiring a modification to the course and student training on using the platform. Without such modification,

this course would unfairly penalize students with differing educational backgrounds and socioeconomic statuses.

Another example from literature that centers marginalization in engineering education to a greater degree is that of Yashin et. al. [35]. These authors examined the experiences of postgraduate engineering education scholars originating in African countries and working in the United States. Yashin et. al. found that "cultural differences have a strong impact on the learning experiences of international students" [35, p. 3], with analogies and discussions often including metaphors or idioms that were culturally based and opaque to international students. In this case, an educator has selected a teaching activity to elicit student behaviour that relies on cultural elements not shared by all students. The result is a course that is constructively aligned for a few, rather than for all.

Note that these potential misalignments are just one incarnation of how marginalization may interact with constructive alignment to produce inequitable student outcomes. More misalignments may be possible, but the goal of this work is to identify the potential for marginalization to interact with constructive alignment; identifying specific instances thereof is relegated to future work.

Education is always advancing and changing, and that is particularly true of engineering education, which needs to keep pace with modern technological advancement to ensure that learning is still relevant to the engineering profession [34]. This constant generation of new technologies and subsequently new teaching activities means it is impossible to create a comprehensive list of teaching activities for eliciting desired student behaviours. Additionally, as Biggs noted, "a teacher cannot always anticipate what valid forms students' constructions may take" [1, p. 358].

It is also important to note that this literature review is focused solely on identifying whether there is the *potential* for marginalizing biases to be present in the concept of constructive alignment and its applications, not identifying whether such biases *have in fact* been present in constructive alignment research and practice. It may be the case that most or all of the uses of constructive alignment to date have addressed marginalization; it may also be the case that they have not. However, even if every single use of constructive alignment has addressed marginalization, this literature review has shown that such considerations are absent from the primary works on constructive alignment that researchers and instructors utilize, and the potential for these biases to be included remains until a model of constructive alignment addressing marginalization is published.

In closing, there is a need for guidance on how educators can select student behaviours and instructional activities while addressing marginalization, especially given the incredible and growing diversity of modern engineering students. As stated by the major professional engineering associations in both Canada and the United States, the highest principle of the engineering profession is to "hold paramount the safety, health, and welfare of the public" [36, 37]. Diverse workplaces are more creative, have a greater variety of information and perspectives, and have better decision-making and problem-solving processes [38]. Marginalization in engineering education therefore creates a less-effective engineering profession that is less able to meet the needs of a large and diverse population. It is critical to

develop a model of constructive alignment that not only avoids propagating marginalization, but actively combats marginalizing processes and systems.

5. Conclusions

Constructive alignment is a popular and effective pedagogical tool, shown to produce large improvements in student learning for comparatively small effort on the part of the instructor. Its use is extensive and the concept has proven benefits in improving graduation rates and reducing course failure rates. However, considerations of marginalization appear to be largely absent from the development and use of constructive alignment throughout its history, prompting a diversity-based analysis of the concept's development and use.

A critical examination of Biggs' 1996 foundational work on constructive alignment, the preceding concept of Cohen's instructional alignment, and Biggs' updated model of constructive alignment, paired with a literature review on marginalization and constructive alignment, show that marginalization was not extensively considered in the creation of constructive alignment and considerations of equity, diversity, and inclusion are largely absent from its implementations. Constructive alignment is a fundamentally subjective pedagogical concept whose implementation is strongly reliant on the skills and knowledge of practitioners, and an interpretivist research paradigm shows that constructive alignment lacks guidelines on marginalization and thus leaves room for instructors' blind spots on marginalization or explicitly marginalizing attitudes to enter applications of constructive alignment. Such lack of consideration of marginalization is a critical absence given that marginalization is socially and culturally rooted, and a lack of consideration of marginalization in developing scientific concepts means their use may allow marginalization to continue or even strengthen it.

Furthermore, the body of engineering students in Canada and the United States is increasingly diverse, and as time passes, new generations of students will present unique educational needs and challenges; if these unique student factors are not considered, courses may be constructively aligned for only a few students rather than all. It is critical to consider students' unique personal traits, as these traits interact with marginalizing systems to produce differences in educational outcomes. A key example of such marginalization in constructive alignment for engineering education is the phenomenon of the technology gap; variances in student access to technology for schoolwork results in in a body of engineering students entering varying technological capacities, disadvantaging them in purportedly "constructively aligned" courses that assume homogeneity in students' technological knowledge and skills. Considering marginalization in this context is critical given the engineering profession's strong reliance on technology and the constant generation of new technologies that are subsequently included in engineering education programmes.

The highest principle of the engineering profession is to safeguard the public welfare. Marginalization within engineering education reduces the diversity of the overall profession, making it less effective and less able to serve public needs. Addressing marginalization means developing systems that do not simply exclude marginalizing processes, but actively combating them. Guidelines are needed on how educators can pay attention to students' diverse backgrounds when implementing constructive alignment, helping to create a diverse engineering profession that is ready and able to meet the needs of a diverse populace.

5.1 Future Work

This paper has identified that considerations of marginalization have been largely absent from the development and use of constructive alignment. A critical piece of future work is to comprehensively categorize the ways in which constructive alignment, without these considerations, may interact with marginalizing biases and systems to produce inequitable student outcomes. This categorization can then be used to develop an updated model of constructive alignment incorporating marginalization considerations.

For future work, the literature review can be expanded and the methodology revised. During the literature review, some articles initially did not meet the search requirements, but closer examination found the necessary connections the review was conducted to find. This indicates a need to refine the search methodology to more effectively capture relevant results. The search terms used are also based on the author's own perception of marginalization and the myriad forms it can take, and the methodology would benefit from the input of researchers with a diversity of perspectives.

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