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The role of neoliberalism in the development of the 'new' engineer

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"…children are not the 'supply' that meets any 'demand' however urgent. They are individual human beings, and the primary concern of the schools should not be with the living they will earn but with the life they will lead" [1].

Universities have traditionally been viewed as places which allow students to broaden their minds, the Latin 'universus' meaning 'the whole, aggregate'. Today, universities can be considered to operate as businesses in competition with one another, their primary purpose being to produce the next generation of workers who aid in maintaining global competitiveness. Students are considered as customers and there is increased pressure on academics to obtain funding, publish, and commercialize their research through the formation of 'spin-out' companies. Whilst neoliberalism ideologies can be considered to influence all disciplines taught within higher education (HE), engineering may be regarded as particularly susceptible to its features, primarily due to it close ties to industry. This has implications for both engineering educators and students.

Heywood [2] has questioned whether HE is to become the next 'bubble', pointing at both the increase in students entering the job market, and the stagnant rate of earnings (p. 111). This type of market failure, in which the price (salary) of the product (graduate) does not reflect its true costs or benefits, is also discussed by Katz and Riley [3] who, in considering HE as a market good, highlight the need to study possible market failures. In their work they discuss five sources of market failure and provide examples of the implications for engineering education research and policy.

One way in which the neoliberal agenda is imposed on society is through new public management (NPM) [4], an approach by which liberal market principles of efficiency and economic gain are implemented in public sector management to make public sectors more effective. This paper sets out to explore how the marketization of HE influences our ability, as educators, to respond to ongoing calls for "future orientated, sustainable and socially responsible engineers" [5]. There are many studies which discuss the impact of the marketization of HE within USA HE. However, the purpose of HE varies according to national characteristics and priorities [6] and there is a need for work which focuses on marketization as it influences UK based engineering education. I will start by outlining some of the key features of the marketization of HE within the UK and move on to discuss the purpose of engineering education. Findings pertaining to the ways in which marketization influence UK engineering education will be framed as initial propositions to be empirically pursued in future studies.

As an 'insider' of the system being studied I feel it is necessary to share a summary of the exercise that was undertaken to surface my interpretative lens. I have been an academic for almost three years. During this time, I have become increasingly interested in questions about who and what engineering is for, as well as who benefits from (or suffers the cost of) engineering decisions. My research interests are born out of the frustrations experienced when faced with a perceived choice between studying 'STEM' based disciplines, and those associated with arts and humanities and the social sciences, as well as conflict between personal and professional identity. I have recently started to engage with the engineering education research (EER) community and begun to experience a lack of support and recognition for EER as a research discipline, things that I had taken for granted when

conducting technical research. More specifically, in the case of this work, I am influenced by the tensions between: what is perceived as 'good practice' within engineering education; how students perceive 'quality' with respect to their learning experiences; and industrial demands placed on engineering graduates. As an engineering educator I have had moments when I have felt conflicted between: spending time conducting 'impactful' research, and that which aligns with my values; adopting teaching practices which meet the expectational norms of students and staff, and those which I believe promotes individual growth of students; 'playing the game' by engaging in teaching practices and including content more likely to result in higher student evaluation scores. I have received negative feedback scores in cases where students do not agree that module content belongs in engineering, and as a new academic I have been cautious to introduce content or tasks which I think will risk teaching scores which are linked to KPIs. I also acknowledge the ways in which I am subject to neoliberal ideals. I chose to study within science, technology, engineering and mathematics (STEM) as I believed that this would make me more employable. As a student I was motivated heavily by grades. The decision of which postgraduate course to study was based on which I would receive funding for. During both my postgraduate and postdoctoral research, I struggled in balancing my responsibilities to industrial funders, academia, the wider society, and myself. In my current role I feel guilt and shame that I am time-privileged and able to work extended hours in the hope of progression, whilst also feeling passionate about issues of social justice.

Neoliberalism within UK Higher Education

Neoliberal ideals began to evade the lives of mainstream British society in the 1970s, a period which was characterized by a period of financialization, a process which involves an increased growth in financial markets compared to the goods and services economy, and which is described as "the increasing role of financial motives, financial markets, financial actors. and financial institutions in the operation of the domestic and international economies" [7] (p. 3). The mass production, profitability, and full employment, associated with the post-war era had led to welfare provision and a greater role of trade unions. However, by the 1960s overproduction resulted in high rates of inflation and social unrest which culminated in the 1976 UK Sterling Crisis, when the Labour Government sought assistance from the International Monetary Fund (IMF). Following this, the UK government questioned the financial restrictions placed on London and a period of financial liberations followed including the 1971 Competition and Credit Control measures, the 1978-79 abolition of exchange controls, and the 1986 Big Bang and Financial Services Act. Such financial deregulation has been considered to set the course for an increasingly financialized economy [8]. It is against this backdrop that we consider the marketization of UK HE.

Marketization within HE has led to behavior similar to that observed in industry and resulted in division of labor and increased levels of specialization [9], with departments becoming business units and staff being discouraged (and in some cases prevented) from teaching and supervising research students within other departments. For academic staff, large student numbers, alongside increases in quality assessment exercises has led to increased workloads.

Marketization of HE within the UK can be considered to have begun in the 1980s when subsidies for international student fees were removed, the funding of research and teaching was separated, and research became selectively funded [10]. 'Top up' loans and tuition fees were introduced in the 1990s, alongside the removal of the divide between universities and polytechnics in 1992. In 2004 a change in the rules for university title enabled institutions without degree awarding powers to become universities [10]. In 2006 'variable' annual fees

of £3,000 were introduced and by 2012 the maximum full-time undergraduate tuition fee was increased to £9,000 per year [10]. By 2015, block grants (government funding administered to institutions according to their student numbers to cover teaching costs) were reduced and only awarded to a small group of taught disciplines [10]. In response to both the decrease in direct funding from the government, and the real value of student fee income, universities have sought alternative sources of revenue (in the form of bank loans, issuing their own bonds on the stock exchange market, or through lease-based structures) in a bid to recruit increased levels of students. This debt-financed capital investment has come to characterize HE within the UK.

Such changes have implications for the way in which universities operate. At the heart of the reform in HE [11] was the notion that universities had customers and that high standards were integral to remaining competitive. The requirement for universities to behave as businesses was made implicit by both their inclusion within the UK Department of Business, Innovation and Skills, and the removal of the student cap which has acted to expand the market and increase competition. At the same time the Higher Education and Research Act resulted in deregulation of Quality Assurance (QA) and the development of a new framework [12] has resulted in QA being left to market forces. Today, numerical data metrics are used as a proxy for 'excellence' and 'quality' and quantitative measures are used in the absence of qualitative information pertaining to student journey or experience. As such, the ability of the HE institutions (HEIs) to charge increased fees became dependent upon their ability to demonstrate 'excellence' as part of the Teaching Excellence Framework [13]. According to TEF, excellence is measured in terms of: student satisfaction via the National Student Survey (NSS), which is completed by final year students on a voluntarily basis; retention of students and continuation rates; and graduate employment and destination. All three measures can be considered to encourage grade inflation and their use means that the position of HEIs within league tables is, in part, dependent on external factors such as the survey completion rate. The results on Graduate Outcomes surveys are dependent on salary values, this implying that education serves economic purposes, but also assumes that graduates will choose roles which pay the most in regions of high average wages, as opposed to aligning with their values. Only this month, the Office for Students (OfS), a non-departmental public body of the Department for Education who acts as the regulator and competition authority for HE in England, has published their consultation on student outcomes. Their plans, which make use of absolute numerical baselines on student outcomes, stipulate that 60% of full-time first-degree students at every university go into "managerial or professional employment" or further study [14]. The introduction of such measures sends clear messages about the role of HE. Students are also protected by the Competition and Markets Authority (CMA) which means that they have consumer rights when 'purchasing' their degree, something which reduces flexibility in course delivery and limits changes that can be made to the course. Perhaps more concerning is that, in some instances, the TEF metrics are included as KPIs of individual academics and can thus be linked to academic pay.

The Role of Higher Education in the Development of the 'New' Engineer

To understand the ways in which the marketization of HE influences engineering education, we must first draw upon education philosophy to understand the role of HE, first in a general sense, and then explicitly with respect to the aims and objectives of engineering education. HE may be considered to serve several purposes, from contributing towards the development of society [15], [16] to the reproduction and supply of labor [17]. Schiro [18] describes four different ideologies which prioritize: enculturation into an academic discipline; contributing

towards the needs of society; righting societal wrongs; or individual growth. The portrayal of education as a public good is particularly relevant in the case of engineering, which is generally considered to contribute toward innovation, growth, and quality of life. From a social justice perspective, the view that HE acts as an enabler of social mobility is currently under question because of the large numbers of graduates and limited number of well-paid jobs [2] and underemployment [19]. In relation to the final ideology which prioritizes 'individual growth', Heywood [2] considers that HE allows for the development of "a philosophical disposition to learning" (p. 34), saying it provides "preparation of individuals for life" (p.34). Handy and Aitken [20] define the 'product' of education as non-visible, "a process of growth within a person" (p. 112). Handy [21] may consider one purpose of education to be helping students to find and grow their 'golden seed', a talent leading to personal fulfillment. Such views take a holistic approach to education and focus on the development of the individual.

These varying roles of HE were recently studied by Brooks, Gupta, Jayadeva & Abrahams [6] who investigated the views held by students from six different European countries. Of interest to this work, is that students from countries in which greater personal financial contributions were required (of which the UK was one), placed stronger emphasis on the preparation for the labor market. It is likely that such findings have implications for the motivations and expectations of students studying within the UK.

Having discussed the role of HE in a general sense, we move to consider the purpose of engineering education specifically, making use of various UK reports to define the characteristics of the 'new' engineer. In recent years there has been an increasing emphasis on the need for engineers to apply systems thinking to solve complex engineering problems whilst considering the wider context [22]. Engineers should behave in a socially responsible and ethical manner whilst demonstrating cultural awareness. They are expected to demonstrate a range of professional skills including communication, teamwork, project and risk management, business awareness and leadership [22], [23] and there is an expectation that they will engage in their own personal development and lifelong learning [22]. They must now demonstrate their ability to "adopt an inclusive approach to engineering" [22]. The Royal Academy of Engineering [24] define six engineering habits of mind; systems thinking; adapting; problem-finding; creative problem-solving; visualizing; and improving. These are accompanied by the following learning habits of mind: ethical consideration; curiosity, open mindedness; resilience; resourcefulness; collaboration; and reflection. It is therefore clear that this 'new' engineer of the future must have skills beyond the technical domain and Spinks, Silburn and Birchall [25] define three roles of an engineer: the first as a technical specialist; the second as an integrator who can work across boundaries in complex environments; and third as a change agent who act as sources of creativity and innovation.

This section has enabled us to gain an understanding of the purpose of engineering education in terms of the desired 'product'. In the next section we will introduce some of the ways in which the marketization of UK HE impacts upon engineering education and development of the 'new' engineer. The various ways in which marketization of HE impacts upon engineering education are inextricably interconnected. Despite this, efforts have been made to separate the features discussed within this paper, which will be introduced in chronological order according to the student journey. As such, the first section will focus on recruitment and marketing of students. The second section will consider the use of learning outcomes (LOs) and will be followed by the assessment of learning and teaching. The final section will consider how the features discussed impact the learning environment and student experience.

Recruitment and Marketing

HE can be considered as a marketplace in which universities compete for students and competition for students, both between universities and disciplines, undoubtedly influences the levels of investment in the use of marketing.

The recruitment of students into engineering has been discussed in the context of supply and demand in both the USA [26], [27] and UK [28], [29] since the world war era. Despite the limited evidence to suggest that demand for engineers outweighs the supply [30], [31], [32], [33] reports about shortages in engineers continue today [34], [35]. As such, there are increasing efforts which focus on marketing and outreach activities with the aim of attracting individuals into the profession. During their investigation into the way Swedish universities represent their engineering programs, Berge, Silver and Danielsson [36] identified 'neoliberal ideals' as one of three societal discourses influencing engineering education and the type of individuals who choose to study it. Within this discourse, engineers play a key role in national competitiveness and are highly sought after within the job market. The authors argue that notions of the 'self-made' engineer, are inconsistent with both the increasing emphasis on social responsibility and sustainability within the curriculum, and the need for awareness "of a gendered, classed, and racialized society". They also highlight the risk that students who believe this message become dissatisfied during study. Similarly, Tseng, Chen, & Sheppard [37] warn that a misalignment of expectations is likely to lead to disappointment and in reduced retention of students. These examples may be considered as evidence of information asymmetries described by Katz & Riley [3] in the context of market failures.

In recent times the focus has shifted, and labor shortages are, in part, attributed to the underrepresentation of certain groups (including women) within the profession. The economic repercussions of homogenous engineering teams are frequently highlighted as reasons to address issues of equality, diversity, and inclusion (EDI) [38], [39], [40]. However, efforts to increase the number of women studying engineering often focus on the valorization of STEM disciplines and appear to concentrate on economic justifications and market driven issues of supply and demand, a case for diversity that some researchers take issue with [41]. In a recent study [42], the author discovered that some UK female students felt a pressure to choose engineering to 'prove' themselves and that they generally accepted adversity as an inevitability of being a woman in engineering and something they would overcome by working harder. Thus, initiatives that focus on retention of women in engineering have been associated with post-feminism and reinforce messages that women should overcome issues by working harder [43]. Such advice is consistent with meritocratic ideals often present in neoliberal societies as well as the values through which women have been suggested to interpret their experiences within engineering. For example, during their analysis of diaries from undergraduate engineering students, Seron, Silbey, Cech, and Rubineau [44] found that female students made use of meritocracy, individualism, and exceptionalism to explain their own membership in engineering. They believed feminism to act as a voice of complaint, thus highlighting the way in which engineering education successfully turns potential critics into agents of cultural reproduction [44] and which is likely to stifle efforts towards EDI within the profession.

Research questions in this area could focus on the extent to which students (particularly those minoritized within engineering) feel pressure to study engineering or compromise the study of different subjects to do so. It would also be interesting to understand whether the valorization of STEM influences their respect for other disciplines and if the discourse used

during marketing campaigns reflect their experience within both engineering education and practice. Questions pertaining to the experience of academics could focus on the degree to which they feel a responsibility for student recruitment figures and whether this influences the ways in which they present the opportunity to study engineering at their institutions.

Learning outcomes

Making use of our neo-liberal lens, we may now consider education as a product which is commodified into separate modules which can each be 'bought' using assessment [45].

Within HE, LOs or, what Heywood [46], [47] correctly refers to as 'intended learning outcomes', are used as a measurement of what students are capable of 'doing' upon completion of their degree. Their use requires one to assume that students develop at the same rate and that there is agreement in the purpose of education. This process fails to allow students to take ownership of their own learning journey and access knowledge on a 'need to know basis', according to their individual needs. Such a view is unlikely to encourage a propensity for lifelong learning.

There are, however, clear advantages in the use of LOs in terms of providing direction to both students and staff, and for means of comparison across different contexts, something which is increasingly emphasized within a globalized economy. Whilst there may not be any specific problems associated with their use, issues may arise if they act to limit the extent of learning and reduce the number of associated emergent [45] or 'unintended outcomes' [48], [49].

Within the UK context, it is the Engineering Council (EC) that is responsible for providing the principal framework which guides engineering course content and sets accreditation threshold standards of competence through AHEP – the Accreditation of Higher Education Programs (as part of The UK Standard for Professional Engineering Competence (UK-SPEC)). In a general sense, accreditation bodies and LOs can be considered to reflect the values held within societies as well as national education and economic agendas, and are shaped by the history of engineering within the UK [50], [51]. The framework is informed by a number of academics, industrialists and sector bodies and the accreditation process claims to "ensure that UK engineering education provides those industry relevant skills" [22]. This not only places a firm emphasis on education being for economic purposes, but also highlights the way in which knowledge is both created and preserved by those in power [52]. LOs can thus be considered as statements about what belongs within engineering [53] with the drawing of disciplinary boundaries acting to "preserve class and gender privilege" [54]. In this sense educators have a powerful influence over those that they teach [55]. An example of how this presents in practice is provided by Xavier, Wint and Orbaek White [56] who interviewed engineering educators within the UK. One of the participants described the way in which the addition of a LOs only came about because of significant "lobbying activity", which was described as "a fight". This has consequences for engineering degrees within the UK, which typically feature few, if any, optional modules and result in a lack of student choice. The lack of flexibility in the contents of engineering which has been defined to "meet the interests and expectations of white men searching for their future careers" [57] has implications for the sense of belonging felt by underrepresented groups and thus the support for EDI.

In common with the US approach to accreditation, Engineering Council (EC) practice 'control at a distance' and individual institutions are free to select how LOs are both achieved

and assessed [58]. Accreditation committees then evaluate whether engineering programs meet the accreditation standards. Within the UK, several Professional Engineering Institutions (PEIs) are licensed to undertake individual accreditation events on behalf of the EC, something that Armstrong [59] claims result in 'lack of precision and clarity' of the LOs. As is proposed to be the case in the USA [58], [60] it is likely that the 'translation' of LOs, flexibility in the approaches used to ensure that they are met, results in an acceptance of the criteria as a minimum standard, with LOs being "ticked off" after one exposure [56] and with success in obtaining accreditation being provided as an excuse not to change or innovate within programs. The different opinions and approaches adopted by different PEIs and panel members is considered to result in program teams acting with caution and in a defensive manner which stifles innovation within their programs [56]. In relation to this, Seron and Sibley [61] have described how engineers are trained to manage risk through greater specification and how LOs can be interpreted as requirements to be met rather than a starting point. The use of accreditation panels thus provides another example of the way in which knowledge is preserved by those in power and there is a need to involve people with a variety of perspectives and experiences within accreditation panels [56].

LOs are typically enforced by the structures and systems present within HE, for example by organization of knowledges into distinct modules timetabled in isolation from one another. This can be considered to result in compartmentalized of knowledge. The formation of 'silos' tends to restrict the use of knowledge to within specific domains and "limit(s) opportunities for them (students) to learn about the strengths and limitations [of disciplines] in real-world contexts and multidisciplinary arenas" [62]. This, of course, has implications for the degree to which we should expect students to recognize the relationships between different subjects and demonstrate the ability to adapt to different situations by transferring and combining knowledge. This is of particular significance given the various forms of knowledge (e.g., tacit, and procedural knowledge) involved in engineering practice [63], [64] and the increasing need for engineers to develop skills necessary to collaborate across disciplines.

Assessment is commonly utilized to ensure that LOs have been met and to obtain a measure of a students' attainment which are used to inform decisions with respect to their future. Confidence in this process assumes reliability of grading and accuracy of grading [65], [66], [67]. Another issue is the validity of assessment and its ability to assess the relevant LOs [68]. For example, when considering written engineering examinations, Furneaux [68] determined there to be one large factor related to the ability to pass examinations. These findings raise questions as to how confident educators are in ensuring that assessments reliably measure intended LOs. Knight [69] has questioned whether complex cognitive tasks can be measured reliability. The need to demonstrate that students have met accreditation LOs may therefore encourage structured forms of assessment [70] that deconceptualize subject knowledge and encourage recall [71] and prevent the use of more authentic assessment that requires students to apply knowledge "in context" [72] during tasks which bear relevance to application of the discipline in real world applications [73] and "reflect the future job situation" [74]. In this sense, Handy [21] goes as far as to suggest that formal education is damaging in that it teaches one how to solve closed problems unaware of the fact that the world contains open problems, with even less awareness of how to solve them.

Research questions in this area could focus on ways in which staff make use of LOs prescribed by EC when designing their courses and whether they feel constrained by their use. It would also be useful to understand the extent to which academics agree with the stipulated LOs. It is also unclear as to whether students are aware of their intended LOs and

one line of investigation may be to ask students how they would define and assess their desired LOs.

Student Evaluation of Teaching (SET)

One way in which the performance of academics is assessed is by making use of student evaluation of teaching (SET) protocols, which are commonly used within universities worldwide. SET typically involves the use of forms which ask students to rate both the course and teachers, often making use of Likert scales. In some UK universities the average values obtained can be used as a judge of performance or key performance indicator (KPI).

Formal use of SET is undoubtedly useful in providing feedback for teachers in terms of teaching effectiveness, and in providing information which can be used to inform course modification and support in administrative decision-making. However, it is important to consider the way in which SET data is interpreted and used, both by the teacher to inform change, and by management, as evidence to support promotion. This is particularly important when considering the sampling bias that may be associated with low return rates [75] and the external factors which can influence SET results [76].

The use of SET to evaluate teaching assumes a common baseline and requires one to assume that students have a clear understanding of what they need to learn and how this may be taught and assessed effectively. In some cases, feedback depends upon students' belief that what they are being taught will be of use to them in future [21]. In the case that students are required to accommodate a new value system, cognitive dissonance can occur, this being more likely for difficult topics or those which involve taking consideration of different perspectives, for example engineering ethics [77]. Although cognitive dissonance does not necessarily result in decreased levels of learning, it may well lead to lower SET scores [78]. Within engineering, such tensions can occur in number of cases. For example, students who are accustomed to structured learning may feel challenged when faced with open ended questions or student-centered approaches [79]. With respect to course content, LOs can be considered as defining what belongs within engineering and can therefore act as a source of student resistance [53]. For example, the use of reflection [80], emphasis on multidisciplinary learning [81] and training in interaction skills [82] have all been resisted by engineering students. These differences in teaching style and course content are often emphasized by the way in which learning is organized within HE (for example using a modular system) and can lead to polarization of expectations and thus the feedback given to different academics.

The correlation between SET scores, and factors such as grade leniency and course difficulty [83] raises questions about the ability of students to develop resilience and about their openness to criticism and different perspectives. Indeed, in recent interviews (unpublished) the author found that some UK engineering academics believed that both SET and TEF resulted in a lack of student resilience, which they primarily defined as 'the ability to keep going'. Lecturers may also feel less inclined to make innovative changes to their courses for fear that their ratings drop [80] especially if we consider Heywood's [2] argument that "those who are rated the best teachers will be those who administer a received curriculum" (p. 97). As he warns "The real danger of such schedules is that if they attend to the acting performance of teachers, they will neglect the learning effectiveness of what is done for students" [77].

Further research in this area could focus on understanding the ways in which academics at different stages of their career make use of student feedback, and how it informs changes to their courses. It would also be interesting to find out if they feel pressure to receive positive feedback and the degree to which this pressure influences their teaching practice, teaching innovation, use of assessment, and grading policies. The extent to which these pressures compromise the ability of academics to help develop students for the workplace is also of interest and it would be useful to collect data from prospective employers. From a student perspective, research could focus on expectations with respect to teaching, assessment, feedback, and availability of lecturers, as well as their rights as a customer of education.

The student experience: The learning environment and engineering culture

Within the UK, the university that students are accepted to study at, and indeed the decision as to whether students can study within HE, depends almost entirely upon their qualifications and attainment up to that point. This, of course, assumes that those with the highest grades in traditional subjects including mathematics will make the best engineers, and restricts access to the engineering. The use of grades for admission purposes can also mean that students begin to associate their worth or value with their academic success.

This process continues throughout their time within HE where the function of grading is to indicate the worth of graduates to potential employers; many engineering firms within the UK specify that graduates must obtain a 2:1 (60-70% grade average) to be eligible for an interview. This has impact on both students who achieve a lower grade, but also for over-achievers who become accustomed to success and expect this to reflect their ability within the workplace.

It is therefore unsurprising that assessment and attainment are a source of student concern, with the number of students within UK HE reporting mental health issues increasing in recent years [84], [85]. As was found in the context of the USA, it is plausible that engineering students suffer mental health issues at a higher rate than those studying other disciplines [86]. For example, the heavy workload involved in studying engineering has been highlighted on several occasions [87], [88], [89], [90], [91]. Godfrey and Parker [92] found that the engineering workload was associated with hardship and suffering. Their analysis revealed an underlying belief that worthwhile tasks were by nature, ‘hard’, and that ‘soft’ content was devalued. They suggest that the ability to ‘take’ such levels of difficulty results in increased sense of achievement and worthiness for graduating students. Stevens, Amos, Jocuns, and Garrison [90] described the way that engineering students justify their efforts and the perceived difficulty of their work, compared to that of other disciplines, by the belief that they will be rewarded by a “comfortable material existence" upon course completion. Tseng, Chen and Sheppard [37] found that engineering students often experienced "curriculum overload” meaning they were unable to pursue other majors, and it is therefore likely that high workloads result in students feeling less able to engage in other meaningful activities such as socializing, sport and engaging with the community.

Such meritocratic beliefs place responsibility upon the individual and can lead to a lack of understanding of the systemic forms of injustice [93]. It is not surprising then, that Jensen and Cross [94] reported not only high levels of stress, anxiety, and depression in engineering students, but that levels were higher for underrepresented students.

The focus on attainment has several implications. Firstly, it is likely to stifle learning through failure and the development on a growth mindset [95], [96]. For example, Riley and Claris [53] describe the tendency of grade motivated students, to "follow the letter of the grading rubric…providing a perceived 'good answer'" as opposed to an authentic one, and it is possible that students avoid the use of creativity and innovation during assessment to mitigate the risk of failure. Secondly, the grading system can result in competition between students [97], who will later compete within the job market. Finally, the assessment of work produced within a team can cause conflicts between peers, particularly in the case that some group members underperform [98]. This can have implications for the ability of students to develop their social skills, something which is of particular relevance given that "students derive the greatest development benefits from engagement in peer networks that expose them to individuals different from themselves" [99]. Peer group teaching can play an important role in helping students to understand themselves; Macmurray [100] claims that it is through relationships that we are able to discover the 'self'.

This seems particularly important given Drucker's [101] belief that the demands faced by the future workforce will necessitate them answering questions about who they are, their strengths and where they can contribute to society. As Heywood [2] reminds us, the person is the base of the engineering process. "The mind that supports the whole activity is the source of our values, beliefs and technical understanding: it is the source of our attitude and opinions in the different social systems in which we find ourselves: it is the driver of our actions" (p.4), adding that "Understanding how our beliefs and values (moral and otherwise) are formed is important to our conduct as engineers and individuals but it belongs primarily to the domains of philosophy and theology which are different languages". Such understanding would require that students are considered as a 'whole' person and are able to see themselves, values, and beliefs within the engineering curriculum, whereas, as Heywood [48] reminds us, formal education is generally only concerned with the first two of Gardner's [102] eight types of intelligence: linguistic; logical mathematical; musical; spatial; bodily-kinesthetic; intrapersonal; interpersonal; and naturalist.

This fundamental lack of consideration for the 'whole' person is a common theme throughout this paper, which has discussed some of the more explicit ways in which the marketization of HE affects engineering education. However, the consequences of neoliberal ideas and marketization can be more subtle (e.g., use of language, culture), can be interrelated in complex ways that render their effects invisible, and can work in synergy. Figure 1 shows a schematic that includes some of the factors considered throughout this paper, alongside their role in creation of the desired 'product', the engineering graduate (as described during *The Role of Higher Education in the Development of the 'New' Engineer*).

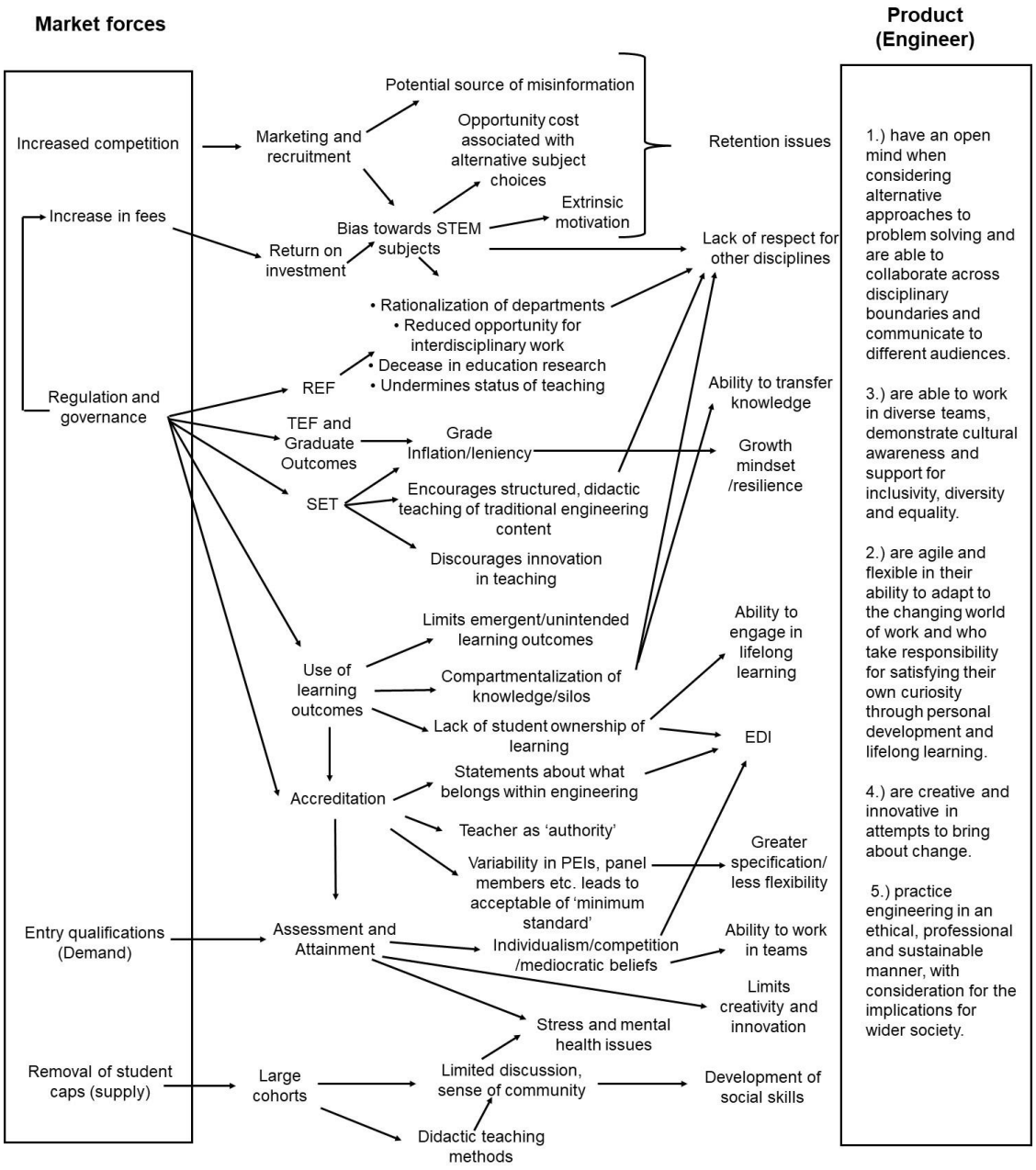

Figure 1: A schematic showing the ways in which the features of neoliberalism, evident within UK engineering education, contribute toward the development of the 'new engineer'.

Limitations

This paper describes several examples of the way in which the marketization of HE influence engineering education within the UK. The examples given are, to some extent, context dependent and by no way exhaustive.

The author acknowledges that treating HE as a market good, acts to oversimplify the HE system, which may instead be considered as a quasi-market. The work primarily focuses on the ways in which aspects of marketization has negatively impacted engineering education, but the necessity for some level of standardization, evaluation of teaching, assessment and grading are accepted.

To make a judgement about the influence of neoliberalism ideals on engineering education, I make assumptions about its purpose, as well the success criteria involved. I have also assumed that the intent of students studying the discipline is to become a practicing engineer, something which it is recognized is not always true, particularly given that the skills obtained by engineers have value in other industries in which the rewards may be greater.

Finally, this paper pays little consideration for the role that engineering education plays in maintaining a profession that serves capitalism, neo-liberalism, 'free market' solutions and inequality [103], [104]. For example, we may consider that the focus on professional skills to be demonstrated by engineers act firstly to reinforce the notion that students must remain competitive within the labor market and adapt to, rather than question, current ways of working [105], but also contribute toward increased levels of effectiveness, productivity, and global competitiveness, and thus the neo-liberal agenda. As such, it is likely that engineers of the future contribute toward economic growth and the maintenance of social un-justice, even if the features of neoliberalism discussed were to have little impact on engineering education.

Conclusions

This paper highlights several tensions. How do we balance our responsibility to provide students with accurate information to help them in selecting degree programs with the responsibility to recruit into our institutions? In what ways can we encourage students to explore themselves, their beliefs, and motivations in a system which values their academic success? How do we introduce students to different forms of knowledge when studying a discipline which values rigor, objectivity, positivism, and reductionism [106]? Can we ensure that students meet the necessary learning outcomes, whilst also having the opportunity to explore their own interests and values? How do we encourage students to explore and develop their creativity and ability to innovate whilst they feel under pressure to obtain high grades? How do we help students to develop independence as a learner when they have been socialized within a structured education system? How do we overcome the culture of competition to ensure that students are able to fully benefit from working with those who have different experiences and perspectives to their own? Perhaps most important to consider, is the extent to which educators should try and address these issues. Shor and Freire [107] described the way in which student resistance to liberative pedagogies was rooted in job anxiety and Freire [108] argues for the need to prepare students for the current (neoliberal, capitalist) state of the world.

Answering these questions is non-trivial and involves making choices which may affect the way in which engineering educators are perceived by students, colleagues, and management. However, neoliberal strategies rely on division and discipline of labor, and any response should focus on acts of solidarity across stakeholders and competitors. If we are to choose our teaching practice, methods of assessment, and course content based on a desire to obtain high SET scores, it is not then for us to judge grade driven or individualistic students who leave non-constructive and negative feedback. As Pawley [109] points out, as educators, most of us "indoctrinate students into neoliberalism" and fail to make students aware of alternative modes of thought which may allow them to "conceive a way of being outside this neoliberal worldview" and indeed, it is difficult to imagine how engineers would develop the skills necessary to behave as change agents within the modern workplace.

Resisting neoliberalism involves building trust, being empathic, and treating students as allies. Educators may allow students to explore their own interests [110], [111], [112], [113],

and make use of scaffolding and frameworks that provide students with the structure needed to make their own decisions about the ways in which they want to demonstrate that they have met the relevant LOs. Such approaches will allow learners to explore their values and motivations and help them to develop an ability to direct their own learning on a ‘need to know basis’. Educators may also ease the emphasis placed on academic success by rewarding other forms of knowledge and varying ways in which students contribute to the class, for example by showing their support for other students.

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