Behaviour Economics of Education in this Technological Era and its Applications to Policies

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1. Introduction

Behavioural economics is a subset of economics which is gaining more appreciation in recent years. It is being utilised to understand phenomena so as to provide explanations and theories in a way that differs from the traditional economic models which assume rational decision making. While behavioural economics has already been applied to different industries, problem areas, and stages within policy design or implementation, there is still a lot of progress to be made. Education is one of the areas in which more behavioural economics activity will be significantly beneficial. Behavioural economics can guide learners and educators to make optimal decisions instead of irrational decisions due to the interplay of biases. Optimal decisions and behaviours in education will result in benefits for the economy too, such as higher numeracy and literacy rates, more consumption and tax payments (from more productivity and higher salaries), higher welfare and quality of life, and a more social population, amongst other benefits.

This research area is also important for further more reasons. We have entered into a technology heavy era and technology uses will continue to increase. Governments and other institutes must begin to utilise technology in both research and implementation of policies. For example, simple and accessible technologies - such as those available through mobile phones - are a direct and cost effective way of achieving specific objectives. EdTech is also a growing field and not only can it be used in institutes for its direct purpose of improving academic achievements, it can also be used alongside interventions and policies. Technology reaps immense benefits; with such a powerful tool that is ever-developing, it is important for it to be continuously incorporated to achieve wide ranging objectives.

This paper explores the behavioural economics of education. Existing research that examines behavioural explanations for suboptimal decision making and behaviours in education is discussed. Through this, a number of behavioural factors are identified which can explain notable instances of irrational decisions and behaviours. Interventions and policies within each of these behavioural barriers are also noted to consider what responses have been strategised to

behavioural issues within education as well as their effectiveness. The use of technology as a tool in both behavioural economics and education is included in this paper's discussion due to the important and necessary role technology has played so far in these areas. The use of technology is on the rise, especially in education. The attention to technology throughout the paper also translates in the ending policy and intervention suggestion. In this section, policies/interventions are suggested with a specific problem in focus. This issue is one which is currently being experienced by many economies - the low proportion of adults with tertiary level qualifications in ICT. Rationally, considering the motivations behind people pursuing education and the benefits reaped from an ICT degree, the proportion of people pursuing and successfully completing a degree in this field should be higher - especially compared to other subject areas (such as business) which no longer provide those benefits. In the last section, this issues is perceived through the angle of each behavioural barrier. Policies and interventions are suggested based on this understanding with the incorporation of technology to achieve the objectives of the policies. While the current understanding may be limited, this can begin and guide further research into the area.

This paper would hopefully manifest into increased discussions on the usage of behavioural economics in understanding irrational behaviours and suboptimal decision making in education. Not only this, but this paper's unique inclusion of technology is essential in this technological era where current and future technological developments are evolving at an unprecedented rate and in unpredictable ways. Currently, behavioural economics has not been employed in education as much as it has in other sectors (such as marketing). The research in this specific field is not as extensive, especially when considering the role and usage of technology. This paper will, hopefully, lead to even more exploration into how this science can be used to implement effective policies in education, with the use of technology.

2. Behavioural Economics

Behavioural economics is a field of study which incorporates the understanding of human beings into the decision making model, which is the base of economic theories. It goes against the principle that humans are rational decision makers and addresses the common irrationality we demonstrate. These behaviours which are deemed irrational, stem from heuristics. Heuristics are rules of thumb - cognitive shortcuts - which people use in difficult or uncertain situations to make decisions (Heuristic, 2019).

Behavioural economics has wide ranging applications, from marketing to public policies - now including the infamous 'nudge theory.' The nudge theory was developed by Richard Thaler. It refers to smaller interventions that influence or encourage 'optimal' decisions. Nudges work by "designing a choice environment to facilitate desired behaviour without prohibiting other options or significantly altering economic incentives" (Thaler & Sunstein, 2008 as cited in Fox & Sitkin, 2015). There are frequent examples of the nudge theory at play, for example when consent is presumed for organ donation forms in the UK. This application of the nudge theory was much more successful than other policies aiming to increase organ donations (Johnson & Goldstein, 2003 as cited in Fox & Sitkin, 2015).

The field of behavioural economics has gained a lot of traction and popularity in recent years. Many government bodies have introduced teams that operate in this space, such as the UK government's Behavioural Insights Team (UK BIT). Many trials have been conducted to guide policy designs and implementation.

Criticism towards the use of behavioural economics in dictating public policies stems from the assessment that traditional economic theories can provide better performing policies than the 'easier way out' with behavioural economics. David Cameron, former UK prime minister, had discussed the utilisation of behavioural economics in reducing electrical bills in a TED talk. "The best way to get someone to cut their electricity bill is to show them their own spending, to show

them what their neighbours are spending, and then show what an energy-conscious neighbour is spending" (Cameron, 2010). However, arguments were raised that that is not the best way to reduce electrical bills and encourage efficiency/sustainability. The best way would be through raising the price of energy, or through a carbon tax (Harford, 2014).

Behavioural economics has only just begun to be applied to public policy in recent years. Furthermore while there are many applications of the theories across industries to achieve a range of objectives, there is a lot of work to be done in the educational sector.

For the most part, policies are based on ideas and theories which stem from neoclassical economics, specifically on the basis of the rational agent assumption. This theory supposes that decision makers "are driven by an evenhanded evaluation of available information and the pursuit of self interest" - they are rational decision makers who are able to consider all choices to determine the most optimal option for themselves (Fox & Sitkin, 2015). Research and work in the field of behavioural economics has produced notable evidence that contradicts the rational agent assumption. Behavioural economics supplies theories that explain these observations of 'irrational' decision making or actions.

The presentation and framing of information and choices has consequential behavioural impact. On ballots, the first candidates are more likely to be chosen because they were listed as first - the ordering of information can influence decisions. If information is presented in groups compared to as singular options, then the singular options are more likely to be chosen. Medical professionals chose medicines that were presented separately more than they chose medicines that were grouped together with other medicines in a listing format. Presenting something as a gain is also more likely to elicit a desired behaviour. People were more likely to pay when the choices were framed as a gain, "taxpayer bonus," compared to when they were framed "as a return to the status quo, tax rebate" (Epley & Gneezy, 2007 as cited in Fox & Sitkin, 2015).

This is also linked to the theory of loss aversion - people would rather opt for the option that avoids losses than the option that gives equivalent gains. An experiment tested this theory with teachers by giving one treatment group a bonus that would later be returned if their students' test results showed no improvement and giving the other treatment group a bonus after the test results were released. The former is presented as a potential loss and the latter as a potential potential gain. The former treatment groups test results showed significant improvement. When the bonus was presented as a potential loss, the performance of the teachers improved - this wasn't the case for when the bonus was presented as a potential gain (Fryer, Levitt, List, & Sadoff, 2012 as cited in Fox & Sitkin, 2015).

Many biases subtly influence human decision making - steering our decisions away from the rationality traditional economists expect. Subtle adjustments - such as in the presentation of information - can influence behaviour so as to prompt decisions which are optimal for individuals and which increase their welfare.

3. Behavioural Economics in Education

Education is considered to be an investment. With investment of time, effort and other factors and resources, individuals will later reap the benefits (such as optimal or maximised welfare). College or university graduates have been reported to earn roughly double the amount high school graduates earn. The rate of employment for college/university graduates is also higher. The economic activities that result from having more college/university graduates - higher tax returns, more consumer spending, more educated/better skilled workforce - can improve a nation's economy.

Traditional economic theories and concepts assume that humans are rational decision makers. However, this is not always the case as humans often make suboptimal decisions. Many students dropout of school, for example, when it could be more optimal for them to continue their education. Traditional economic ideas have the basic assumption that rational forward-looking systems are used - the future is primarily considered when making decisions. A more appropriate model would be one which demonstrates long-term decision making through two "systems" which includes a not-forward-looking system (System 1) and a forward-looking system (System 2). System 1 weighs present costs and benefits and assesses importance according to the present, while System 2 considers future costs and benefits. Due to the fact that it is easier for humans to assess present feelings than to contemplate future feelings, the present cost of investing in education is much more obvious than the future cost or benefits. This interplay between the systems can provide reasoning for suboptimal economic decisions.

The effect these two systems have on decision making are further intensified by the fact that children and teenagers "are especially prone to short-term thinking" (Hanushek, Machin, & Woessmann, 2016). Bettinger and Slonim's (2007) study found that over 43% of the participants (children aged 5-16) demonstrated "hyperbolic discounting" - the participants chose the immediate $10 gift certificate instead of waiting two months for a $25 one. They inferred that over a quarter of the participants' choices were not rationally explainable; however as the

participants' age increased, the likelihood of irrational behaviors decreased (Hanushek, Machin, & Woessmann, 2016). This present bias affects behaviours and choices when it comes to education. School assessments like homework and studying for exams, as well as school-related activities such as applying to further education institutes and applying for financial aid or scholarships seem costly due to this present bias. While on the other hand, distractions such as entertainment or socialising seem more beneficial than academic tasks - present costs of educational activities are overemphasised and future benefits of these activities are understated.

There are a number of ways (through education) in which the emphasis of System 1 over System 2 can be tackled. According to Oeropoulos and Salvanes (2011), "increased education may help students focus less on the present by decreasing the current disutility from costly actions such as studying or completing assignments"(Hanushek, Machin, & Woessmann, 2016). Studying now will better prepare students for future materials and assessments, and therefore reduce the present cost of doing these tasks. On the other hand, "Becker and Mulligan (1997) suggest that more schooling may reduce the remoteness of students' future preferences" (Hanushek, Machin, & Woessmann, 2016). Through problem-solving tasks, students can develop considerations for different possible situations, especially situations about their future adulthood. There is also evidence supporting the notion that formal education can have positive effects on executive function and 'soft' skills or characteristics such as "self-control, patience, and focus" (Hanushek, Machin, & Woessmann, 2016). This can lead to the minimisation of suboptimal decision-making in relation to hyperbolic discounting and/or present bias.

Another idea which explains suboptimal decision making in education is the idea of people giving in to automatic thinking and depending too much on routine. This habit of making automatic decisions based on information people already have that is more easily accessible excludes any new knowledge a person has acquired or could acquire. When the routine needs to be changed, a lack of appropriate adaptation of the routine can lead to lower welfare compared to the potential welfare with appropriate adjustment. In one's educational journey, routine often requires change, especially when transitioning between educational stages, programs, or

institutes. If the usual academic/school routine is not adjusted during the time of applications to tertiary institutes, students may limit their options and/or submit suboptimal applications therefore negatively impacting their potential welfare. If routine is also not adjusted once reaching the tertiary institute, potential welfare will also be negatively affected (poor performance, low grades, dropping out, unsuccessful graduation).

Not only this, but people could "miss out on acquiring better information" because of lack of resources, but also because of System 1's automatic thinking process (Hanushek, Machin, & Woessmann, 2016). People could end up making decisions based on this automatic thinking with the information that they already have, instead of acquiring new information regardless of how accessible it is. Hoxby and Avery (2013) demonstrated this concept in a study which found that "bright students from disadvantaged backgrounds" did not apply to selective colleges with lower costs compared to "less selective schools they know about" (Hanushek, Machin, & Woessmann, 2016). This occurred in this technological age where the relevant information is easily accessible and is free on the internet. Low income families may also be deterred from acquiring new knowledge due to other stressors (e.g. financial burdens) as well as a lack of (human and capital) resources compared to other income groups. Such students' applications to more selective schools has been proven to be improved by information packages sent directly to the students - application and enrolment rates increased significantly at selective schools.

Avery and Kane (2004) found that secondary school students "from low-income family backgrounds" are misinformed on the real "tuition levels, financial aid, and the admission process" (Hanushek, Machin, & Woessmann, 2016). According to Usher (1998), low income groups overestimate tuition costs on average to be double the actual cost, and underestimate the income difference between high school graduates and university graduates (Hanushek, Machin, & Woessmann, 2016).

When considering the cost and benefits of investing in education, this does not only involve personal costs and benefits (time, effort, results, or welfare) but it also includes social costs and

benefits. These social costs and benefits tie into the social group to which the person belongs to or identifies with. Identity related thinking becomes important during adolescence. Students' decisions are often based on how their behaviours either differ from or are consistent with their social groups' behaviours. This current perception may affect the student's expectations and beliefs about their future preferences. Such projection bias ("people's assumption that their tastes or preferences will remain the same over time" (Loewenstein et al., 2003 as cited in Projection bias, 2019)) can accentuate the effects of the System 1 thinking. The social behaviours may not align with those decisions that are optimal for that person, and therefore result in poor academic performance, absenteeism, and more negative effects on welfare. To tackle this bias and improve academic performance, student's may be primed "to focus on positive identities related to learning and intellectual curiosity." (Benjamin et al., 2010 as cited in Hanushek, Machin, & Woessmann, 2016). "Identities may relate to social groups, but may also relate to attitudes which can be primed through passages or films." (Dweck and Leggett, 1988; Dweck and Sorich, 1999 as cited in Hanushek, Machin, & Woessmann, 2016)

3.1 Research and Interventions

3.1.1 Identity Related Beliefs

There has been considerable research conducted and interventions designed to focus on identity related thinking affecting educational activity and attainments. Research has shown that students from lower income and similar groups are less likely to apply to university, and are more likely to apply to less selective universities when they do apply (regardless of how well they have performed compared to students in higher income groups). Some students do not apply to better schools or for financial aid due to such inaccurate mental models of which types of students the applications are targeted at or which types of students can qualify for certain universities or courses. This issue of inaccurate mental models is observed more in students who are already enrolled into college/university (Insights and Opportunities: College Student Financial Health and Behavioral Science, 2018).

Such mental models and beliefs regarding one's social belonging can distance students from their educational institutes and activities. Student's can build negative beliefs in the beginning of their higher education journey. Perceptions which question their abilities and belongingness combined with insufficient positive communications or feedback can result in student's withdrawing themselves from college/university.

18% of first year students at San Francisco State University left before the first day of their second year (Fostering a Sense of Belonging: Forming a new narrative about freshman year, 2016). Ideas 42 designed an intervention to tackle this problem. They used "a low-cost, scalable digital messaging campaign" which addressed these negative mental models and belongingness doubts. They reframed these perceptions and beliefs as being a shared experience for all students. There were 3 parts to the intervention. A short 3.5 minute video with various students and alumni talking about their experiences and how they prevailed over them. This was followed by a reflective questionnaire which guided students to determine their own first year plan. Lastly, 11 SMS' and emails were sent once a month throughout the academic year. These messages were based on each student's specific responses in the questionnaire and used the student's own language. The content reiterated the information shared in the video as well as refocusing on the student's individual plans. Some were actionable messages (e.g. completing a financial aid form) and some were purely motivational. The intervention had a significant effect on the different participant groups. For example, a group of students who were first generation students from low income backgrounds, experienced a 6.7% increase in their GPA, an 8.5% increase in the retention rate (91% after the intervention), and a 7.5% increase in credit completion (Fostering a Sense of Belonging: Forming a new narrative about freshman year, 2016). Overall, the treatment group had higher GPAs, retention rates, and credit completion compared to the control group.

Sharing the experiences of similar role models with students (video) and simple personalised messages over a certain period of time (SMS and emails) can work to reverse the negative mental models and social identity beliefs that students can develop. Students' identities were

primed to adapt their beliefs and therefore behaviours towards optimal activities. For most tertiary education institutes, especially in developed economies, such an intervention would not be significantly costly. For this intervention, "at the scale of the entire incoming freshman class of Metro students at SF State," it would cost 470 USD "for each additional student who would persist to sophomore year" (Fostering a Sense of Belonging: Forming a new narrative about freshman year, 2016).

Another experimental study by Steele & Aronson (1995) explored what effects priming participants in regards to their identities had on their performance. The participants were African American students. Prior to a test, they had to declare their race. The test results showed that they "correctly solved about half as many items on average as those not asked their race" (Steele & Aronson, 1995 as cited in Ross, White, Wright, & Knapp, 2013). This demonstrates the powerful influence priming can have on behaviours when done at important points in their educational journey. "When situations prime negative identities involving stereotypes, they can significantly undercut students' performance and widen the gap between college aspirations and attainment (Ross, White, Wright, & Knapp, 2013). The same influence is observed with positive self identities. "For example, a student who feels that she is part of an academic community and that this identity represents her 'true' self tends to fair better academically" (Farrington et al., 2012; Harvey & Schroder, 1963; Oyserman, Bybee, & Terry, 2006 as cited in Ross, White, Wright, & Knapp, 2013).

Priming, framing and presentation of information needs to be carefully designed and implemented so as to avoid stressors and eliciting feelings of non being. American research supports this theory. They show that minority students can experience "stereotype threat" and are apprehensive about conforming to negative stereotypes related to their identities (Bird & Hunt, 2019). Interventions with continuous messages regarding financial aid or required administrative tasks can heighten anxieties relating to feelings of non belonging. Therefore, interventions need to be carefully designed to avoid these negative triggers but also to positively influence applications and enrolments.

Interventions targeted at financial aid applications that utilise this understanding of self identity beliefs and models, show that making accurate information on the cost and benefits of universities accessible to students was counterproductive. It is extremely important to be careful on how much an intervention or policy brings attention to finances and financial aid, as well as how it presents this information. The UK's BIT conducted a trial in 10 schools in Somerset where they sent students simple messages regarding finances. The result was "a statistically significant negative impact on aspirations - making students less likely to want to attend university" (Bird & Hunt, 2019). However, a talk that presented the same information as well as a personal speech on the speaker's life had the opposite effect of increasing aspiration. This can be explained by the theory that such information and interventions may prompt financial stress and "feelings of non-being" (Bird & Hunt, 2019). The positive effect a role model is shown to have in such studies can be attributed to the alignment of students' identities with the role model's identity.

3.1.2 Choice Overload

Suboptimal decision making can also result from a large variety of complicated choices. An abundance of choices "require students to collect and evaluate information from disparate sources about a range of different features of colleges and select one" (Insights and Opportunities: College Student Financial Health and Behavioral Science, 2018). Assuming the appropriate information has been gathered, analysing and evaluating it requires experience which student's lack. The lack of experience and guidance combined with profusion of complex choices may result in students making suboptimal decisions resulting from certain processes. For example, students may opt for choices which they can recall immediately or more easily. Other barriers may lead to students to choose such default options - all leading to a suboptimal outcome.

There are a number of sources and tools which aim to help students overcome these issues. "Online college scorecards and list builders can be a useful resource, but they don't account for the often-counterintuitive ways people actually make decisions and take actions" (Insights and Opportunities: College Student Financial Health and Behavioral Science, 2018). Governments have also developed technological tools to assist students in judging higher education institutes and related factors. However, these options are not yet fully successful. They can be difficult and non-intuitive to use for comparison and evaluation and may not already have all the data required. A successful higher education choice comparison resource would significantly avoid the availability bias student's can often default to (Insights and Opportunities: College Student Financial Health and Behavioral Science, 2018).

Students also can be held back from partaking in optimal activities or making optimal decisions due to the triggering effect some educational activities can have (such as enrolling in courses, applying for financial aid, etc.). Ostriching - "tendency to avoid stress-inducing information" - can occur often due to the overwhelming presentation of information, lack of guidance, and other stressors the student's are experiencing (Insights and Opportunities: College Student Financial Health and Behavioral Science, 2018).

The cognitive tax that an over-abundance of choice can have has been exemplified in many other situations. Companies that have many retirement saving choices in the 401(k) plans usually result in less employees registering for retirement savings at all. This shows one extreme, that not only can a profusion of choice result in selecting a suboptimal option, it may result in complete inactivity - making no choice at all (Iyengar, Huberman, & Jiang, 2004 as cited in Ross, White, Wright, & Knapp, 2013). Furthermore, the presentation of complicated choices can have a significant influence on one's decisions.

In an educational context, the presentation of complex choices and adjustment of student's decision making "architecture" can nudge students' actions. One significant problem area is that issues in the enrollment of required courses can negatively affect a student's academic

performance and/or delay their successful graduation. Without reducing the large number of courses that are available for enrolment, certain adjustments can nudge them towards enrolling in required courses. This can be done by prioritising these required courses - enrolling the student's automatically (and then allowing changes after students submit a request to do so). This nudging strategy can also be applied to other problem areas related to enrollment such as difficulty in determining a reasonable timetable. Technology can be a great asset for these objectives. Softwares can easily suggest many timetables based on student's requirements or choices. This is both cost and time effective, and can avoid issues that arise with using human resources (e.g. advisors or administrators). However, great care does need to be taken as too much "structuring" could limit the student or their choices and therefore result in suboptimal decisions or actions - therefore making the nudge strategy counterintuitive (Ross, White, Wright, & Knapp, 2013).

3.1.3 Cognitive Exertion

Cognitive effort refers to the effort that is required for our brain to process and perform tasks such as problem solving, logical reasoning, abstract thinking, etc. Cognitive bandwidth encapsulates this understanding of cognitive effort and cognitive capacity as well as something called executive control. Executive control refers to the mental "ability to manage our cognitive activities, including planning, attention, and initiating and inhibiting actions" (Mullainathan & Shafir, 2014). Tasks which take up a significant amount of cognitive capacity can impose a cognitive bandwidth tax and affect the processing and performance of other activities as there is limited (scarce) capacity.

A lot of cognitive effort is required especially when it comes to monetary resources and scarcity - poverty, debt, etc. The financial situation of a student not only affects their academic attainments in regards to the costs that come with schooling (tuition fees, textbook costs, etc.) but also in regards to the 'cognitive bandwidth tax.' A third of U.S. college students "say that financial stressors have negatively impacted their academic performance" (Improving Student

Financial Well-Being: The connection between financial health and a degree, 2016). This experience is more significant for low-income students.

An intervention at Valencia College (a community college in America), involved researching the financial challenges the students experienced - roughly half of the students at Valencia College accepted financial aid. Some of the challenges revolved around having numerous jobs, having to support relatives, and having problems in repaying loans and debts. Most students who accepted financial aid, received it at the beginning of the semester in a lump-sum amount. The most significant reported challenge was in regards to managing their finances. Behavioural economics can explain this challenge - "being in a state with scarce resources actually makes people worse at tasks that require cognitive exertion" (Improving Student Financial Well-Being: The connection between financial health and a degree, 2016). Cognitive exertion is required not only in educational activities but also in managing finances. The intervention designed involved an "online goal-setting and plan-making activity that prompts students to set financial goals and walks them through the key decisions they have to make to put their goals into action," - they delivered these prompts through text messages (Improving Student Financial Well-Being: The connection between financial health and a degree, 2016). The treatment group planned their financial goals and actions, received text prompts weekly, and reported on their performance at the end of the semester; the control group participated in a financial education exercise. The treatment group showed more improvement in their financial management and financial health than the control group. The self reported financial satisfaction of the treatment group was 10% higher than the control group, and the self reported ability to access emergency funds was higher too (by 8.8%). This intervention provided further evidence for educational policies: "it is possible to help students manage their finance by removing small behavioural barriers to action using goal-setting and plan-making exercises" (Improving Student Financial Well-Being: The connection between financial health and a degree, 2016). With a lessened financial burden on students, the cognitive bandwidth tax experienced could also be lessened. This would free up more of their cognitive capacity, allowing them to focus their efforts on other tasks and activities.

3.1.4 Hassle Factors

Another issue which forms a barrier for students attempting or completing tasks are hassle factors. A simple form can seem demanding and hasslesome. "Even seemingly small hassle factors have been shown in various contexts to keep us from following through on actions we know are valuable and intend to do" (Cabinet Office Behavioural Insights Team, 2011 as cited in Insights and Opportunities: College Student Financial Health and Behavioral Science, 2018). The effect of hassle factors are significantly exaggerated - especially when the action requires many preparatory activities or has many substeps. These can result in late application submissions, and sometimes no submission at all (Insights and Opportunities: College Student Financial Health and Behavioral Science, 2018). There are some solutions which have shown to work in tackling these issues. Considering interventions focused on FAFSA (Free Application for Federal Student Aid), one-on-one, in-person and personalised guidance has resulted in an increase of FAFSA submission (Bettinger, Long, Oreopoulos, & Sanbonmatsu, 2012 as cited in Insights and Opportunities: College Student Financial Health and Behavioral Science, 2018). However, due to the resources required and the quality of the support, this solution is not easily scalable. Another intervention which is scalable utilises simple technology. Text messages and emails have been used to send multiple nudges to submit FAFSA forms. These messages and emails were more complex than simple reminders to submit the application - they broke down the application into smaller steps and "offered timely, actionable, and motivating reminders." While the effects of this intervention was not as significant as the personalised guidance intervention, it did achieve positive effects on application submission, was cost-effective, and is scalable (Insights and Opportunities: College Student Financial Health and Behavioral Science, 2018).

A study of hassle factors and policy design around these factors was conducted on senior Yale students in regards to tetanus vaccinations. Even with cautionary advice regarding tetanus, only 3% of senior Yale students got the vaccination. In this study by Leventhal et al. (1965), their

intervention provided students with "information, a campus map with the infirmary circled, a list of times when immunizations were available and a prompt to think about a convenient appointment time" (Ross, White, Wright, & Knapp, 2013). While most of this information was easily accessible, accessing them was a hassle. With the already known information made more accessible, the hassle in getting vaccinated was reduced. 28% of student's got vaccinated as a result of this intervention - a 25% increase.

Additionally, negative feedback - only receiving communication in regards to something negative, such as an incomplete activity or poor performance - can have the same effects that hassles do. Negative feedback can reduce students' activities towards necessary tasks (Making It Through Enrollment: Exploring new ways of communicating, 2016).

In education, not only is it important to recognise the hassle factors students experience, but it is also necessary to design processes or activities which reduce the friction in completing the activities. As shown in the previous studies, this can result in a drastic improvement in student's behaviours resulting in positive outcomes.

3.1.5 Present Bias

Another area within education which leads to suboptimal decision making is in regards to hyperbolic discounting or the present bias - valuing present or closer benefits over future benefits, and overvaluing present costs and undervaluing future costs. Present costs to education are discouraging to people regardless of the benefits they will reap over the long-run. For example, the tuition fees for university courses discourage students from considering higher education, despite the fact that the higher wages they will achieve as a result of the degrees will allow them to pay off any debt. Financial assistance is also often ignored in this biased cost-benefit consideration. A large body of research suggests that "the exact framing of fees, loans, and grants" can have a significant influence on decision making (Bird & Hunt, 2019).

As discussed earlier, present bias can cause students to value present or closer benefits compared to benefits from future activities or it can cause them to value present costs over future costs (and vice versa). This can manifest through unexplained absences, incomplete assignments, and non-optimal drop-outs. Students may choose to sleep instead of go to a morning class, socialise instead of finish their homework - overvalue the present benefit of relaxation or enjoyment over the future benefit of good grades and a successful graduation (Boosting New York Transfer High School Graduation Rates, 2019).

Non-complex interventions can mitigate the occurrence of present bias. This can be done so by guiding students to think more of their present selves and future before a time period where a certain event, activity, or decision needs to happen. A group of students at McGill University took part in an activity where they were asked to consider their long-term goals and their plans to work towards those goals. The GPA of these students (who were considered to be academically at risk), was 0.5 points higher than the control group (Morisano et al., 2010 as cited in Lavecchia, Liu, & Oreopoulos, 2015). Such results illustrate that directing students to thinking of the long term can work to avoid the minimisation of benefits reaped from future activities, and avoid the emphasis of costs incurred in the present - countering the present bias.

3.1.6 Reference Points (Prospect Theory & Reference Dependence)

After improving the presentation of options available and the process to interact with those options (school applications, financial aid applications, course enrollments, etc.), people may still make suboptimal decisions because of reference dependence. Reference dependence is an assumption from prospect theory - evaluation of options and the results guide decisions which are made on the basis of reference points (Reference dependence, 2019). An example which demonstrates this is when purchasing a property, the asking price can influence the actual price one would pay (Thaler & Sunstein, 2009, p.23-34 as cited in Ross, White, Wright, & Knapp, 2013).

In an educational context, there are many scenarios in which reference points can lead to suboptimal decision making. One important scenario which has shown to result in students limiting their higher education choices, or not pursuing higher education at all, is inflating the actual cost of studying at college/university due to reference points. A study found that 56% of participants said they had a lot of knowledge about college costs, and yet tuition costs were overestimated by 212% for 4 year institutes and 180% for 2 year ones (Ikenberry & Hartle, 1998 as cited in Ross, White, Wright, & Knapp, 2013). This result can be attributed to students allocating the most notable information on tuition costs which are usually regarding the more expensive institutes. Evidently, the most notable information is not always accurate. Dependence on such reference points also dismisses other options which can reduce the overall cost of higher education (such as financial aid or budgeting strategies).

In another study by Pallais, 2009, an educational testing company allowed students to send one more free test report for their college applications (from 3 to 4). This has an influential result where the range of schools students applied to increased. This could have a positive effect of student's applying to more selective schools instead of restricting their options. The result could be explained by the phenomenon that people defer to reference points (such as the standard number of free test results that can be sent to colleges and universities) when making difficult choices or facing uncertainty - "How many schools should I apply to?" (Ross, White, Wright, & Knapp, 2013). The future income of a student from a low-income background could increase by approximately over 6,000 USD as a result of sending one more test report to one more college or university (Pallais, 2009 as cited in Ross, White, Wright, & Knapp, 2013). The effects of a simple framing of a reference point can have significant and expansive effects - beneficial and detrimental. The presentation of information which can anchor one's reference points (information on tuition costs for each institute being more notable and accessible), and redefining reference points (indirectly increasing the number and variety of colleges/universities a student applies to) can nudge student's towards different behaviours (Ross, White, Wright, & Knapp, 2013).

4. Technology as a Tool

In the education sector, there are many existing technologies and softwares that are used either to facilitate teaching (EdTech, online lessons, laptops and tablets in schools, etc.) or as processes (submitting applications, enrolling in courses, system integration, etc.). There is no dearth of softwares or apps in the educational space. Infamous options are available from online courses (e.g. Coursera), online tutoring and educational materials (e.g. Khan Academy) to language learning apps (e.g. DuoLingo). "The overall market for online education projected to reach $350 Billion by 2025" (Li & Lalani, 2020).

Another technology which facilitates teaching has sharply risen in the past few months. Online learning and teaching has become a cornerstone in this COVID-19 pandemic. More than 1.2 billion students' education has been disrupted across 186 countries (Li & Lalani, 2020). Schools, colleges, and universities have transferred onto online platforms such as Zoom, Google Classrooms, and Microsoft Teams. There are ongoing discussions on how this will translate into the future: Would there be more online learning opportunities? Will institutes incorporate and rely on more technologies for educational purposes? E-learning has already demonstrated its effects through an increased retention of information. "On average, students retain 25-60% more material when learning online compared to only 8-10% in a classroom. E-learning requires 40-60% less time to learn than in a traditional classroom setting because students can learn at their own pace," they can "accelerate through concepts as they choose" (Li & Lalani, 2020). However this depends on the capabilities of different nations and institutes - the digital divide.

Technology or technological concepts (such as gamification) have also had numerous applications in behavioural economics. An infamous case of the successful use of gamification is the 'Piano Staircase' in Sweden. A staircase in a subway was made interactive so that when used, it would play a variety of notes. This was successful in incentivising people to use stairs instead of escalators - 66% more people used the stairs after the 'Piano Staircase' was implemented

(Volkswagen, 2009 as cited in Peeters, Megens, van den Hoven, Hummels, & Brombacher, 2013).

In education, gamification can be used with behavioural economics theories and principles to promote certain behaviours. When using gamification in an educational context, the purpose and objective is to ensure that the promoted behaviour is maintained even after the process. This is best achieved by avoiding "extrinsic motivators and rewards" (Huang & Saman, 2013). One example of how gamification could be used in this context is JDFI Academy using gamification to increase student's engagement.

JDFI Academy utilised game elements in an undergraduate course. In the design of this gamification, the professor recognised multiple pain points ("factor preventing students from advancing through the learning program and/or achieving the objectives") (Huang & Saman, 2013). These pain points revolved mainly around procrastination, timing of assignments and feedback, and application of taught concepts. Basic game elements were added to an online system such as experience points, leaderboards, storylines with missions for the assignments, and bonus questions as side quests. This case study found that 71% of the students agreed that the game "element of levelling up encouraged them to complete their assignments" and 33% were motivated by the social game elements (leaderboards and achievements) (Huang & Saman, 2013). Submission times (procrastination pain point) also showed significant improvement - students submitted work more than two days before the deadline compared to previously submitting it less than a day before the deadline. Additionally, the mid-semester survey (linked to experience points game element) was completed in 3 days compared to the 1.5 week previous completion time (Huang & Saman, 2013) . This successful case shows that gamification elements can be adopted into existing educational programmes and courses to improve performance and promote optimal behaviours.

Additionally, another simple technology has been used in numerous interventions in the education sector. SMS, text messages, emails have been successful in targeting behavioural

barriers and prompting optimal decision making and actions. They are both cost effective and scalable.

A tutoring centre in a college in America (West Kentucky Community and Technical College) saw very low number of students attending - approximately only 4% attended a minimum of one tutoring period in a semester. The intervention used emails, sent from the college, to nudge not only students but also staff to improve attendance. The email to the students was sent in the beginning of the semester with the aim of presenting the centre as accessible and important to their academics. The email to the teaching staff focused on the timing of encouragement from staff to students which would motivate the students to attend sessions at the centre. "The student emails made students 34% more likely to go to tutoring, and they attended 53% more tutoring sessions overall" (Nudging for college success, 2016). The email sent to staff resulted in a 300% increase in teaching staff referrals of students to the tutoring centre (Nudging for college success, 2016).

At another higher education institute in America (Arizona State University), less than a fifth of students submitted completed financial aid application forms before the initial deadline. After this deadline, the sources of financial aid could reduce over time therefore restricting the financial aid options available to the students. Timely emails were sent to students participating in the intervention. A group of the participants also had emails sent to their parents. Before the intervention, 18% of the students submitted the financial aid forms before the deadline. After the intervention, the results showed that this group of participants (student and parent emails) were now 72% more likely to submit the application in time compared to the control group. The results also showed an increase in the financial aid submission in the next academic year - from 67% to 73% of students submitting the application by the deadline (Nudging for college success, 2016).

These exemplary studies demonstrate how behaviourally informed interventions using low-cost and scalable technologies can have significant improvements in student's actions. The

technology is accessible by most of the population - whether it be students, staff, or parents. The outcomes have been significant and positive.

Educational entities and institutions need to more heavily involve technology in their processes. Behavioural economics also needs to be incorporated to guide students to make decisions which are optimal for themselves. It is even more crucial to employ updated technologies and software and increase it's usage because of the upcoming generation. "There is a generational shift occurring among the college-going population as GEN Z now predominates" (Mutimer & O'Brien, 2018). Gen Z were born in an environment where the digital and online were surging. "That context has produced a hypercognitive generation very comfortable with collecting and cross-referencing many sources of information and with integrating virtual and offline experiences" (Francis & Hoefel, 2018). It is therefore crucial that educational institutes facilitate this generation in their decision making process through technologies. Technologies which can assist institutes in behaviourally guiding students is referred to as Nudge Tech. Nudge Tech includes various technologies that can "work together to achieve timely personalized interaction with students, staff and faculty such as text (SMS) reminders."Other technologies within Nudge Tech include "algorithmic analytics, machine learning, and AI" (Lowendahl, Thayer, Morgan, Yanckello, Resnick, & Revang 2018 as cited in Mutimer & O'Brien, 2018). Nudge Tech was recognised in the top strategic technologies that are relevant to higher education in 2018 (Mutimer & O'Brien, 2018).

Furthermore, incorporation of technologies in this way will provide institutions and educational entities with data that will be able to guide further behaviourally informed usages of technologies, process, and interventions. Such data gathered on the result of the usages of these technologies will be able to predict the behavioural response to following interventions and initiatives. "System integration, data analytics, AI (both machine and deep learning) and so on, provide unparalleled opportunities for institutions to distinguish patterns in student behaviors and to nudge accordingly" (Mutimer & O'Brien, 2018).

5. How Can Behavioural Economics, Education, and Technology Intersect to Dictate Policies

Behavioural economics needs to be applied to educational policies in two ways: policy design, and policy implementation. While behavioural economics has mainly been utilised in the implementation of policies, recently it has started to be used in the design of policies (OECD, 2017). To determine whether to use either or both should depend on the problem. Can insights derived from behavioural economics theories, research, and interventions drive effective results? Can these insights develop a policy design that will effectively eliminate the problem? Can these insights direct the successful implementation of policy and test its effectiveness?

With policy design, understanding and evaluating problem areas through a behavioural perspective can provide a distinctive understanding and lead to effective solutions. However, it may be difficult to accurately pinpoint the behavioural reasonings for certain suboptimal decisions and actions. The difficulty arises from differentiating between all the possible factors that affect a particular event. For example, is a non-permanent difficult economic climate causing students to opt out of pursuing higher education or is it fundamentally due to behavioural barriers such as inaccurate reference points? Therefore, to make the identification of the problem precise and the resulting behaviourally advised policies or interventions effective, it is important to have iterations in the research and policy design, and implementation process. These iterations and consistent evaluations will translate the behavioural understanding into actionable policies that result in successful outcomes. For example, through iterations one may discover that messages sent from certain 'role models' is more effective for different student demographics.

For this purpose, experimentation can be determined as the most suitable method. Comparisons between treatment and control groups can demonstrate the effectiveness of policies and interventions. Experimentation allows for the evaluation of solely the intervention, ignoring other factors, through this comparison. It is more appropriate than other research methods (interviews, surveys, covert/overt observations, focus groups, etc.) For example, in research

methods such as interviews or surveys, "participants are prone to confirmation bias, or a tendency to fabricate rational yet often inaccurate explanations of events that align with their pre-existing beliefs." [Oswald & Grosjean, 2004 as cited in Ross, White, Wright, & Knapp, 2013). Findings from the iterative research and design experiments and evaluations can direct other research and policy initiatives too.

5.1 Policy and Intervention Suggestions

For the purpose of this paper, in this last section I will consider possible behavioural barriers that explain the occurrence of a specific problem. These behavioural considerations and the resulting policy/intervention suggestions can be the basis to guide future research and experimentation that can more precisely determine the accurate behavioural barriers and the appropriate elements of the policy/intervention. There are many problem areas in education which indicate suboptimal decision making, as discussed in this paper - absenteeism and drop-outs, lack of application completions, inappropriate school and course selections, lack of assignment completions, abnormally low performance in academic assessments, and low student engagement. There is an arising specific problem that is being faced by many economies that I will consider for the purpose of this section. It is not only a problem area when considering the economic needs of a nation, but also indicates that people are not making rational decisions.

There is currently a great and increasing demand for graduates with skills and knowledge in information and communications technologies (ICT) - specifically in the OECD countries. A higher skilled labour market with qualifications in ICT or even knowledge using ICT is needed in response to the technological advancements countries are experiencing. This labour market need will likely continue as further technological progress is evidently expected.

Students who hold ICT undergraduate or equivalent degrees "have the highest average employment rate across the OECD," at 90% (OECD, 2019). Additionally, the gender pay gap for those holding ICT degrees is the lowest across OECD countries. Not only this, but amongst the

highest salaries, ICT has been found as one of the areas in which employees hold qualifications. For at least four OECD countries, the highest salaries are linked to ICT qualifications (OECD, 2019).

These high employment rates and high salary outcomes, amongst other factors, are definitely incentives for people entering the labour market. For those seeking financial returns on their educational investment, and the resulting personal and social outcomes (e.g. higher quality of life, increased participation and engagement in cultural and sport events), a degree in ICT should be a rational consideration (OECD, 2019). However, the proportion of those entering tertiary education and graduating with an ICT or related degree does not reflect this rational decision making. Only 4% of tertiary level students in OECD countries have graduated with a degree in ICT (on average). The highest percentage of the population with ICT degrees is only at 7% (in Costa Rica and Luxembourg). The lowest is experienced by the Russian Federation and Turkey - just 1% of adults hold tertiary level degrees in ICT. Most students are still not opting for ICT or related qualifications - the rate is either stable or decreasing across the OECD countries (OECD, 2019).

The low rates of adults with tertiary level qualifications in ICT is definitely a problem. A higher proportion, at least, are incentivized to pursue education for the financial and social returns amongst other returns. It is logical to expect rational decision makers to pursue qualifications related to ICT considering the economic and social outcomes related to such degrees. However this is not the case with the shockingly low proportion of adults enrolling in and graduating with such degrees. Governments and policymakers also have an incentive to correct this problem. Governments are facing a shortage of individuals with the required technological skills - the high employment rates and salaries is representative of the demand for a technologically capable labour market. This should stimulate governments and policymakers to explore the behavioural barriers allowing for this problem to occur, and to develop policies targeting this.

<u>5.1.1 Identity Related Beliefs</u>

Behavioural Barrier:

Gender bias is one of the factors that can play a role in the low number of adults pursuing and completing ICT degrees. There is an enormous gap in the proportion of males and females who are graduating with ICT related degrees - 72% are males and only 28% are females (World Bank, 2019). This gender difference can be attributed to stereotypes and the resulting identity related beliefs female students hold. Research has demonstrated that disinterest in ICT related subject areas begins later in secondary school for female students (Zagami et al., 2015 as cited in Spieler, Oates-Indruchova, & Slany). Female students show similar interest levels in STEM subjects as boys till GCSE's in the UK (14-16 year olds), after which the interest falls (Philbin, 2016). This decrease in interest is likely not due to the academic capabilities of female students as a larger number of female students achieved better grades for A-Level STEM subjects than male students (Philbin, 2016).

Females can suffer from stereotypes associated with their gender's abilities and with ICT and related subjects/fields which force them away from ICT and related higher education options. Gender stereotypes which identify girls as being less able than boys in mathematical subjects are at play in distancing females from the STEM field in the future. Feeling as if they do not belong due to their identity also plays a role in pushing females away from ICT (Spieler, Oates-Indruchova, & Slany). The stereotype of people or females in the ICT field as being geeky in appearance and obsessive of video games and movies such as Star Trek or Star Wars is not quite attractive to most females. Such stereotypes have a negative influence on females as demonstrated by Cheryan et al. (2011) and lead to decisions which distance them from ICT (Spieler, Oates-Indruchova, & Slany).

Policy or Intervention:

Policies/interventions focused on identity related beliefs should prime those identities which encourage the occurrence of optimal behaviours. These identities should be primed at the time of decision making or right before (Ross, White, Wright, & Knapp, 2013). Making people focus on their gender prior to when they have to make a future subject related decision might result in suboptimal decision making if they are female and if they hold negative self identity beliefs in regards to different subject areas or fields (such as ICT). A simple policy/intervention could prime other identities students relate to that would invoke positive identity beliefs. However, a policy/intervention that directly addresses the stereotype at play, can have a more impactful impression. Gender beliefs can be primed so that the stereotype threat is no longer at play and the gender related negative identity beliefs are eradicated.

This can be achieved through the use of role models. Females in tech that do not conform to the stereotypical appearance or behaviours (geeky or nerdy, with glasses, interested in video games, etc.) can not only limit the stereotype and its effects, but can also reverse it. Such "ordinary" females "are easier to identify with" and their academic and professional journey can be motivating for female students (Young et. al, 2013 as cited in Spieler, Oates-Indruchova, & Slany).

- Female students should be connected with other females who have pursued ICT and related degrees. These females who are either still in higher education or are employed in the ICT field will be the role models for the younger female students. The policy/intervention could be focused on those female students who have shown some interest in the ICT field in early secondary education.
- The policy/intervention should be introduced around the ages of 14-16, when students are enrolled in their GCSEs (and equivalent early secondary school academic qualifications) and should continue till at least their A-levels or IB qualifications at the ages of 16-18 (or equivalent upper secondary academic qualifications). This is because research has shown

disinterest in the ICT subject area rise in this time period and decisions regarding higher education pathways and career aspirations are usually made around this time period as well.

- The role models should connect with the female students so as to encourage familiarity between them; this is to allow the female students to breakdown and possibly reverse the gender stereotype that could influence them. The role models should share their experiences in the ICT subject area/field - positive and negative - to demonstrate how they overcame certain challenges and to bring to light the benefits they experienced. This experience can prove to younger female students that they too can have a relatable journey to their role model and are capable of succeeding and enjoying such subject areas/fields.

- The role models should have heavier involvement in the time period leading up to a time when the younger female students need to make decisions (upper secondary qualification subject choices, university subject/major choices). Invoking positive beliefs regarding their gender identity prior to an influential period can overcome the effects of a stereotype or negative identity belief.

- Simple technology which is accessible to all should be used such as smartphone messaging apps, or even emails. Inaccessible technology may make students feel even more out of place and could have some counter/negative effect.

- Possible iterations should explore the following effects to ensure the policy/intervention is as effective as possible in at least mitigating stereotyped negative identity beliefs if not fully reversing them:
  - At which age level or academic qualification level is introduction of such a policy/intervention most effective? This can be trialled at younger ages (earlier in secondary school) or later (in upper secondary school).
  - Which other identities or experiences of the role models are relevant? How can they positively or negatively influence the student's perception and what effect would this have on the effectiveness of the role model on a student's identity beliefs? For example, are female role models from low-income or difficult

backgrounds more effective for certain groups? Do other similarities between role models and female students have an effect?

- ○ How often should the interactions take place? What sort of discussions and activities should the interactions entail? How much time is needed, prior to an important decision, for the interactions to be significantly influential?
- ○ Do different softwares or apps (methods of communications) have any effect? Should other connections with the role models also be established?

5.1.2 Choice Overload

Behavioural Barrier:

An abundance of choice could overwhelm students and lead them to relying on information or options they recall first or more easily. These secondary and higher education options are more likely to be traditional subject areas or professional fields which are already quite populated by graduates. The higher the rate of people pursuing degrees in areas such as business, the more notable that area of study or field becomes as an option. Therefore technology related fields are not relied on as much in the face of too many options, especially as it's demand is surging only recently. To tackle this, ICT and related degrees need to be presented as a distinct option and this can be achieved through the presentation of all possible choices.

- ● Possible higher education options need to be presented in a way that is more organised and easily digestible. Choices should not be structured so much so as to restrict students' decision making which would lead to suboptimal decisions. Choices can be architecturally presented in an interactive map system where specific courses, degrees or majors are presented through general education streams (refer to Figure 1). This can allow students to more precisely determine their desired and optimal educational journey and career aspirations while making sure that ICT is a notable and valid area of choice.
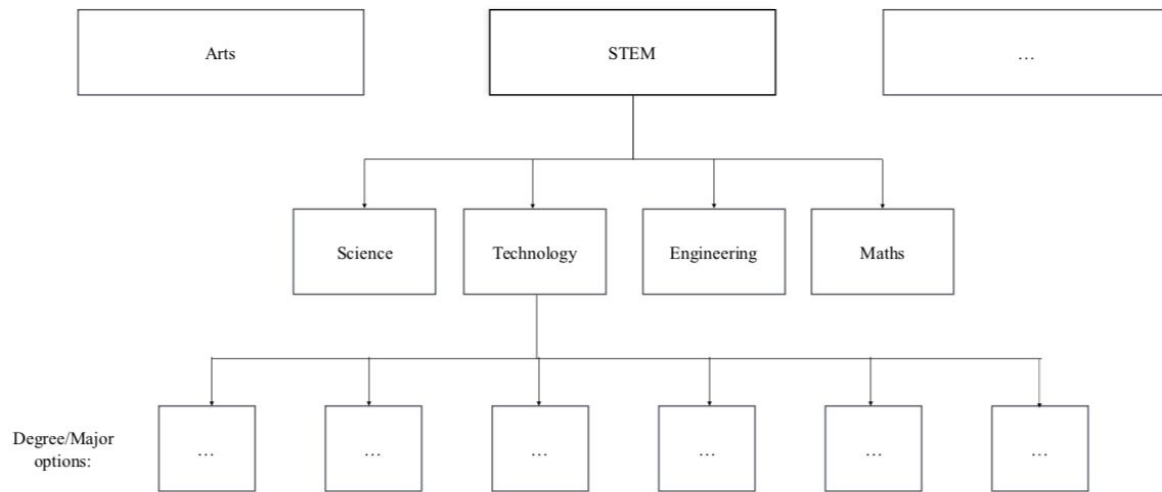
Figure 1: General visual example of possible interactive map with degree/major options organised into different levels.

- Key information regarding the requirements, degree/major details, and career options should be easily accessible through this interactive map system.
- If the educational institutes have the financial and technological resources to make the map available individually to students it should be able to be personalised by students to keep the options they are considering relevant, and remove non-relevant degree/major options from view. This can reduce the choice overload, therefore reducing the effects of this behavioural barrier and bias.
- Through design iterations, what needs to be determined is:
  - At which educational level is the behavioural barrier of choice overload most influential on student decision making, resulting in suboptimal decision making (and low rates of students graduating with ICT degrees)?
  - What structure or presentation of course options is effective in tackling this behavioural barrier? Is an interactive map software sufficient in improving optimal decision making?

<u>5.1.3 Cognitive Exertion</u>

Behavioural Barrier:

Educational and other activities which require a significant amount of cognitive exertion can be taxing to the point where performance is affected. Scarce cognitive capacity can be dedicated to certain actions, leaving other actions unattended to. This can lead to lower academic performance and eventually result in students switching majors or courses, dropping out, or not successfully completing their graduation. It can also lead to some required actions not being attempted or completed at all, such as applications or enrollments (any of which may be suboptimal for individual students). A study demonstrated that students were more unlikely to continue a Computer Science major after an introductory course because they "perceived the pace and workload to be too heavy" (Barker, McDowell, & Kalahar). The cognitive exertion that students may expect with demanding degrees such as ICT and related subjects could deter students away from completing their higher education in this subject area. This behavioural barrier may account for the low rate of graduates in the ICT field because of student's switching, dropping out or not graduating successfully because of the cognitive bandwidth tax they experience.

Policy or Intervention:

Policy/interventions tackling this behavioural barrier may be best utilised in higher education or when students are already enrolled in ICT and related subject areas. When they have begun on their commitment to ICT through enrolling in an introductory class or declaring it as a major, that is when this intervention should be introduced to prevent students from switching subjects, dropping out, or not completing graduation at all. This could be done by decreasing the perceived and actual cognitive effort that would be required for tasks and activities in ICT courses. This intervention can begin at an introductory ICT course level and can be adapted for overall degrees and majors as appropriate.

- Reminders should be sent to enrolled students as checkpoints over a certain period of time. These reminders could be regarding completing assignments, reviewing notes, preparing in advance for assessments, and so on. The reminders act as nudges to students to complete certain smaller tasks within the overall activity by a certain time. This can reduce the cognitive exertion that would be required if these activities and tasks were done in one go, in a shorter time period, or closer to the deadline - if they were not broken down and reminded to the students over time. Such reminders lift some of the new burden of academic planning and organisation that students can experience in tertiary education as well.

- Use gamification as a tool to promote students to behave optimally in regards to the reminders. Completing certain sub-tasks within a certain time period after the reminder can award students a certain number of 'points' which can place them on a leaderboard. Being recognised as top performers for their effort can be an impactful motivator (as studies have shown).

- Reminders can be sent to students through existing platforms and systems used by educational institutes. Existing platforms can also be simply used for the purpose of gamification by updating the scores as a grade and having a published leaderboard.

- The following can guide possible research and design iterations to ascertain the successfulness of such a policy in reducing the cognitive exertion required or the cognitive bandwidth tax of ICT degrees:
    - Is reducing the cognitive exertion of ICT course assignments/assessments impactful in retaining student's interests in ICT courses/degrees? What other taxing activities do ICT subject students experience which affect their performance and completion in this subject area?
    - Do the reminders of sub-tasks reduce the overall cognitive exertion required or the cognitive bandwidth task experienced by students? Is it more effective to reduce the cognitive effort required in ICT courses tasks/activities compared to

reducing the cognitive effort required for academic organisation or other
activities?

○ What is the optimal task 'breakdown' and the optimal time period required for
different types of assignments/assessments that will be beneficial in reducing
cognitive exertion?

○ Are these gamification elements (score system, leadership board) the most
suitable for the objective of this policy/intervention? What are the most effective
gamification elements that can be incorporated?

5.1.4 Hassle Factors

Behavioural Barrier:

Hassle factors at any stage of a student's education journey may prevent them from eventually
graduating with an ICT degree (for those students for which an ICT degree is optimal). Hassle
factors may withdraw students from ICT during the research, application, enrolment, or study
completion stage. Unnecessary friction requires further effort from an individual to complete a
task that may already be taxing. Simple interventions and policies would minimise the hassles.
However, the occurrence of hassle factors needs to be determined to be able to tackle it directly.
More research is required on this behavioural barrier in the context of degree and course
selection (specifically regarding ICT degrees/majors).

Possible policy and interventions could be as follows.

● To reduce hassle factors in the research, application, and enrolment stage,
information should be presented directly and clearly to avoid confusion. Such as
information on course or major requirements, document or material requirements
for applications, etc. Personalised guidance should be made available to motivate
and assist students in these processes.

- To reduce hassle factors throughout a student's educational ICT journey, advisors or other appropriate people should initiate connections with students and certain intervals throughout the semester or term. This should be done with the aim of recognising any hasslesome activities the students may be experiencing and addressing these hassles. Such advisors should also positively motivate students through hasslesome processes and educational activities and readily provide guidance.
- Regardless of which stage a student is at (research, pre-enrolment, enrolled), information should be presented clearly (even if it already known), and required activities should be simplified to reduce the hassle factors.
- Educational institutes should utilise technology to recognise at which points students are experiencing hassle factors. This could be determined by the wait time on a certain screen/page for certain educational activities, or by determining which section of certain applications/enrolment tasks are most delayed. Such data gathered from student's behaviours on platforms can support institutes in determining the hasslesome stages or activities.
- Much research is needed to determine key understanding of the role of this behavioural barrier in the low number of students enrolling or graduating with ICT degrees specifically. Such required information could be regarding the following:
  - Are there significant hassles prior to a student's enrolment into an ICT degree preventing them from enrolling in the first place (e.g. in the research or application stage)?
  - Are there significant hassles during one's study of ICT which result in them dropping out or switching degrees/majors?
  - What are the unique hassles that are preventing higher rates of students graduating in the ICT field?

5.1.5 Present Bias

Behavioural Barrier:

Present bias is a behavioural barrier that often leads to suboptimal decision making due to hyperbolic discounting. In education, specifically in regards to this problem, the present bias may permit students to pursue educational streams which may not be the most optimal choice. Student's may opt for suboptimal course choices due to overvaluing the present benefits or costs of certain activities or factors . This could involve decisions based on their peer's educational decisions, the teachers for different courses, the perceived effort required, and other non-educational benefits (Jin, Muriel, & Sibieta). Student's may decide not to pursue ICT due to the perceived coursework load or difficulty of this subject area, as well as the fact that their peers are also unlikely to pursue ICT.

Policy or Intervention:

Making students aware of their future goals and the future benefits they want to experience can position students in a way that can avoid the present bias. This can prevent them from overvaluing present benefits (more relaxation or enjoyment) and undervaluing future benefits (better academic performance or employment opportunities). If and when ICT related subject areas or fields align with their future objectives, students can be more likely to continue the pursuit of education and profession in ICT without opting for other options due to the present bias.

Research has found that the perceived gravity of decisions and the relevance of future activities and experiences can affect the influence of the present bias on decision making. The effects of present bias can be mitigated if students realise the importance of their decisions (Whelan and McHugh, 2009 as cited in Jin, Muriel, & Sibieta). The relevance of future activities and experiences can be increased by nudging students to develop specific goals (Ross, White,

Wright, & Knapp, 2013). This can be achieved by guiding students to consider their future selves, what they want to achieve and how, and how their future selves would respond to present activities and behaviours.

For those students that value and are incentivised by financial returns, better employment or labour market conditions (such as high employment rates), and other job characteristics which can be attained through the ICT field (problem solving, creative and innovative thinking, etc.), ICT should be an optimal option and this should be demonstrated through higher rates of adults with degrees in ICT. The suggested policy/intervention focuses on using the future self of students to guide them in making optimal course, degree, and career progression choices.

- Run exercises where students are inspired to think of their future selves and devise specific objectives and action plans to achieve the future self. This can be done through diary style softwares and applications which track goals and progress, and trigger students to visualise their optimal future self at certain time intervals.
- For those institutes with more financial or technological resources, utilising technologies such as VR or softwares that develop future images of students can have a significant impression. Hershfield et al. (2011) used computer generated images of the older versions of their participants responding to different decisions - frowning when the participant had not saved enough for retirement and smiling when participants wanted to save more. The results showed that this positively affected the participants retirement saving plans (Ross, White, Wright, & Knapp, 2013). Such direct visualisation can increase the impact of considering your future self; it can make the future appear more relevant and the current decisions and behaviour more critical.
- The above suggestions should be implemented prior to a significant decision so as to ensure that the present bias does not influence the decision of students. Such methods of mitigating the effects of the present bias should nudge students to not undervalue the future benefits and overvalue the present costs of ICT and related degrees.

- The following questions would need to be answered through research and design iterations to optimise these policy/intervention suggestions:
  - What costs and benefits play a significant part in distancing students from pursuing ICT related degrees as a result of the present bias?
  - In what time period should these policies/interventions be implemented? How much time prior to a significant decision is required for these intervention suggestions to result in optimal decision making?
  - Which of the two technology suggestions (diary style goal tracking software and apps, VR and future visualisation softwares) is most effective? Is there a significant difference in the effects the two technology suggestions have on the influence of the present bias or the decisions students make?

5.1.6 Reference Points

Behavioural Barrier:

Inaccurate reference points and dependence on incorrect information can distance students from deciding to pursue ICT. ICT may not be the first option to come to mind when students are considering their future educational and professional plans; many are likely to consider traditional subjects and fields such as business, law, medicine, etc., which one is likely to recall first. A number of studies have found that students do not pursue ICT related studies because they either have the wrong information or no information at all. Another reason is that students are not aware of the career options available to those with an ICT or related degree (Carter, 2006 as cited in Lenox, Jesse, & Woratschek, 2012). Students hold inaccurate beliefs regarding the employment or labour market and the job responsibilities (Hilpern, 2012). Research also shows that students make decisions about their major and future education based on "self developed information" (Pollacia and Lomerson, 2006 as cited in Lenox, Jesse, & Woratschek, 2012).

Policy or Intervention:

In tackling the behavioural barrier of reference points, the presentation of information that anchor's students reference points needs to be altered so that relevant and accurate information is both notable and accessible. And, the reference points need to be redefined so as to include ICT and related degrees with other traditional and more easily recalled academic or professional areas (e.g. law, business, medicine, etc.). This can be achieved through the following suggestions.

- Updated and accurate information should be made more easily available regarding possible higher education streams and associated career options. Online platforms should be used for this purpose, such as trusted and recognised education institution websites. Previous research has found that 53% of students had used information available online (especially forums) as their primary source when researching ICT related majors (Woratschek & Lenox, 2009; Pollacia & Lomerson, 2006 as cited in Lenox, Jesse, & Woratschek, 2012). It is therefore necessary to have accurate and reliable information readily available and easily accessible online where most students go for their research.
- Research has also found that students also rely on information from family, parents, and other students and peers (Woratschek & Lenox, 2009; Pollacia & Lomerson, 2006 as cited in Lenox, Jesse, & Woratschek, 2012). Therefore, these sources should also be updated with the correct information so they do not deliver inaccurate reference points. This can be done by sending up to date information on the ICT sector, labour market/employment conditions, career options and their job activities/responsibilities to parents, teachers, and students. This information could be sent through emails in the form of newsletters or as a fact sheet document to serve as a reference point.
- The following would need to be confirm through further research and trials:
  - Which online platform or method of communication presents information in the most accessible and notable way? Which is the most effective way to communicate with parents, students, and teachers?
  - Do these suggestions result in more accurate reference points?

6. Conclusion

This paper investigated the behavioural economics of education by understanding research that has been conducted, identifying the interventions or policies that have been applied, and recognising what the results of such experiments and policies suggest. Six behavioural barriers have been identified which influence students' decisions throughout their educational journeys. Beliefs and biases that pivot student's away from behaviours that are optimal to them have been discussed - often they are intertwined with each other - such as the interplay of hassle factors and cognitive tax. These behavioural barriers have ranging effects on student's and as observed in the paper the responding policies have a similar variety of effects - from ineffective to surprising results, and both positive and negative. This only demonstrates the need for iterative research, experimentation, policy design, and implementation.

While there has been a rise of applying behavioural economic theories to understand irrational behaviours in education, there is still an extensive gap. Most of the research discussed in this paper is focused on the developed world and does not consider a vast range of cultures. This will be a necessary gap that will need to be filled through future research. Many of the studies are also focused around upper secondary and tertiary level education. There are many other levels and forms of education which also deserve attention - such as early education, mature students, and non-traditional educational methods and qualifications.

This paper also reveals the serious need for the incorporation of technology in research, education, policy implementation and more. Technology is a tool which is accessible to most of the population. The uses of technology are vast and ever expanding. The benefits this tool can provide are boundless. With behavioural economics, technology can achieve objectives, improve welfare, and improve economies in a simple and cost-effective manner.

The last section of this paper attempts to provide behavioural explanations for the specific problem of low ICT graduates in the OECD countries through the lens of each of the behavioural

barriers. While some of the behavioural barriers can be applied to the specific problems (identity related beliefs, or reference points), others are currently not so good in this application (e.g. hassle factors). These areas need more research to provide substantial and satisfying explanations and understanding. Possible policies and interventions are also ideated based on the understanding developed in the paper. The suggested areas of research only goes to show how much more information we require to be able to not only tackle but understand the occurrence of such problems. These suggestions can hopefully guide future research and policy work.

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