Facilitating Current Higher Education Trends With Behavioral Strategies

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***Abstract*—Higher education is a major social institution with a multifaceted influence as for instance it increases the literacy and critical thinking level of the general population, it is one of the primary means of social mobility, and it provides the highly skilled personnel necessary to maintain and increase the technological momentum which is fundamental in contemporary societies. Nevertheless, the majority of the elements comprising the strategic culture of higher education have been forged with different objectives in mind. Therefore, in order for higher education institutions to remain highly relevant, a thorough review and renewal of this culture is required. This potentially radical transformation can be greatly facilitated through a set of behavioral techniques explicitly designed to encourage the shift from an outdated but familiar situation to a beneficial but unknown one. To corroborate the validity and feasibility of the proposed transition methodologies, successful applications of behavioral principles to all levels of education around the globe are provided and discussed. Moreover, evaluation metrics for assessing the results of a behavioral strategy are given.**

***Index Terms*—higher education, behavioral analytics, strategic culture, multimodal learning, affective learning**

1. Introduction

It is widely accepted that contemporary societies, primarily the industrial [1] and the information-based ones [2], are knowledge driven and heavily reliant on science and technology. Perhaps the most well-known recent example is the set of theory and practices under the collective label of Industry 4.0 with its unprecendeted and extensive integration of artificial intelligence (AI) across the entire manufacturing life cycle which already constitute a fundamental part of the working culture of the industrial base in most, if not all, advanced nations [3] [4] [5]. In light of this, maintaining and increasing the aforementioned technological momentum in the face of competition coming from multiple directions is critical for information-based societies [6]. In turn, this depends heavily on the size as well as on the skill level of the technically oriented personnel in a given society.

Higher education institutions in addition to the other important functions they perform, such as facilitating social mobility, they provide the bulk of such personnel and until very recently they were in practice the only issuers of certified knowledge recognized by the state and industry for a number of reasons including the high academic standards, a pervasive culture encouraging innovation, and values such as integrity, critical thinking, and individual effort [7].

With the advent of the Internet, however, and in conjunction with recent advances in a number of fields including deep learning, behavioral sciences, affective computing, computational neurosciences, and educational technology a new digital era has emerged and along with it new requirements. Consequently, the role of universities and their strategic culture have to be redefined. Since changes of this magnitude, essentially tantamount to a paradigm shift, are difficult to implement, they are expected to take a considerable amount of time and also to incurr significant cost, it makes perfect sense to find ways to faciliate them. One way to achieve this is to rely on behavioral methods which have been already successfully applied to other fields including transportation design, hospital management, robotics, social media, and environmental and political campaigns.

The twofold primary research objective of this conference paper is to enumerate current trends in higher education, based on an extensive bibliographic survey, and how these can be implemented easier with behavioral techniques taken from other fields. As a secondary objective, metrics for assessing the effectiveness of behavioral strategies are given. This work to the best of the knowledge of the authors is one of the few focusing on a behavioral design in education, which differentiates itself from previous approaches.

The remainder of this conference paper is structured as follows. In section 2 the recent scientific literature regarding affective computing, behavioral sciences, and educational research is briefly overviewed. Educational trends are given in section 3, while in section 4 it is shown how these trends can be implemented with minimized social friction. Future research directions are given in 5. Acronyms are explained the first time they are encountered in text. Finally, table 1 summarizes the notation of this work.

2. Previous Work

Higher education is currently undergoing a worldwide paradigm shift [8], including key countries besides the West like Russia [9], Brazil [10], and a number of African nations

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TABLE 1. NOTATION OF THIS CONFERENCE PAPER.

Symbol	Meaning	First in
$\triangleq$	Definition or equality by definition	Eq. (1)
$\{s_1, \ldots, s_n\}$	Set with elements $s_1, \ldots, s_n$	Eq. (1)
$\lvert\cdot\rvert$	Set cardinality functional	Eq. (4)
$\tau(\cdot, \cdot)$	Tanimoto set similarity coefficient	Eq. (4)
$\nu(\cdot, \cdot)$	Tversky set similarity index	Eq. (5)
$S_1 \setminus S_2$	Asymmetric set difference	Eq. (5)
$\text{prob}\{\Omega\}$	Probability of event Ω occurring	Eq. (2)

[11], where internationalization, lifelong learning, science, technology, engineering, art, and mathematics (STEAM) portfolio, and educational technology play a major role [12]. Moreover, affective methodologies have garnered considerable attention both on their own right [13] and as part of distance learning [14], especially during the recent pandemic [15]. Balancing between internationalization and local culture and governance is the focus of [16]. The above trends are put in the context of Industry 4.0 in [17]. Competition in higher education is explored in [18]. The benefits of deep learning in higher education are discussed in [19].

There are a number of ways to mine and collect the information necessary to implement a behavioral strategy [20] and evaluate its effectiveness from an affective viewpoint [21]. Affective computing is the theory and practice of detecting, processing, and appropriately responding to humans based on their emotional state [22] and has many applications including robotics [23] and video games [24] and their associated analytics [25], especially the ways to give players the feeling of fairness even if the game is biased in favor of them [26]. Human emotional states and their dynamics they can be harnessed from multimedia such as video [27], speech [28], or a multimodal combination thereof [29]. Social media also abound with affective information in particular in political conversations [30], product evaluation and commercial campaigns [31], and long social arguments [32]. Moreover, affective information can come from neuroimaging such as fMRI, taken for instance during cognitive tasks such as facial recognition [33], cross-modal activity [34], or image classification [35], or EEG signals [36]. Since brain circuits are naturally represented as graphs, graph signal processing (GSP) can estimate or recover the emotional state with graph reconstruction [37], nested unrolling [38], spatial filtering [39], or approximation [40].

Various behavioral principles have been already applied to a wide range of diverse fields including public policy [41], COVID-19 vaccination considerations [42], item annotation in cultural portals [43], recent protective strategies for alcohol abuse [44], altering consumer behavior [45], robotc affective digital twins of humans [46], career choice motivation [47], and finding trusted candidates in LinkedIn [48]. In education there have been recently proposed behavioral strategies for remote students with emotional disorders [49], training teachers with behavioral methods [50], assisting low-income youth to enter post-secondary education [51], fusing data from heterogeneous sources to feed behavioral indicators [52], and assessing the influence of various forms of praise from teachers to students [53]. Recent comprehensive surveys about the applications of behavioral sciences to education are [54] and [55].

3. Educational Trends

3.1. Paradigm Shift

In order to examine the paradigm shift higher education is currently undergoing, it is neccesary first to define through their respective primary aspects the existing model as well as what it appears to be the prevalent one in the near future. In order to construct both models various bibliographic sources from section 2 as well as a number of TEDx vieos[1][2][3]. In the last video in particular is given a general overview of the challenges currently facing higher education institutions. Starting from the political satire of Aristophanes in classical Athens regarding the univerities of the time, the speaker moves on the issue of student loans in the US. Moreover, the video title itself is highly indicative of the viewpoints presented therein and it is a vociferous call to action for re-evaluating the overall role of higher education.

Among the strongest forces driving this paradigm shift are the rapid technological progress which has rendered possible many innovative ideas, the radical economical transformations including circular and sharing economy, and social needs and conditions. This is shown in figure 1.

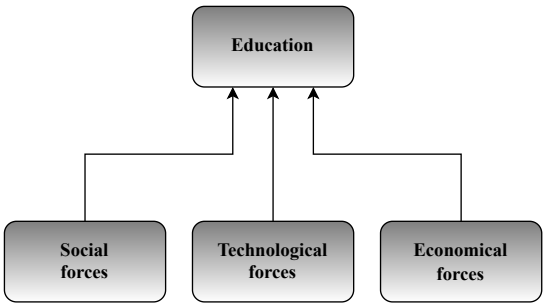

Figure 1. Forces driving educational paradigms.

Said technological progress has actually led to the rapid diminishing of the useful duration of the knowledge offered by undergraduate and graduate programs diminishes. This is attibuted in part to the intensive research conducted in univrsities as well as in public and private research labs at planet scale along with almost instant dissemination.

The historical roots of the currently widely accepted Western archtype of the accomplished professional possessing a unique skillset and vast experience as well as a high social status stemming from this very skillset can be traced back to the days of the first industrial revolution of the Victorian era, even to the art of the time[4].

1. www.youtube.com/watch?v=2pbkWZMeUts
2. www.youtube.com/watch?v=fZi1f2OS7nU
3. www.youtube.com/watch?v=ZWikNxscWc8
4. A distant echo of this trend is the steampunk artistic genre.

Based on the above, the following paradigm summarizes the major existing viewpoints in higher education:

Paradigm 1 (Current paradigm). Heavy emphasis is placed on a centralized and self-contained curriculum. The key points for achieving this through universities are:

- Development of a unique skillset.
- Assessment in a rigorous and top-down way.
- Interaction on-campus.
- Access to a large alumni network.

Higher education shaped professionals by not only providing skills along with a major networking opportunity, but also being among the few social institutions authorized to do so, often backed by law. These professionals either were employed as senior administration staff in factories and in the civil service or as freelancers and consultants.

The new higher educational paradigm driven by recent major social and technological forces in conjunction with a new economic landscape, although is it still being shaped, it can be summarized as follows based on the available data:

Paradigm 2 ((Predicted) future paradigm). The educational barycenter consists now of distributing knowledge dissemination in space and time over an open ended process. This is accomplished through the following:

- Development of an evolving skillset.
- Assessment from instructors and peers.
- Interaction on-campus and online.
- Access to an enhanced network.

Unlike the skills offered by the existing educational paradigm, the ones provided by the new paradigm, wherever it has been the official curriculum or it was *de facto* part of educational portfolio, can be readily applied to a broad spectrum of positions across a diverse number of financial and technological sectors. The latter is even more true with the recent advent of Industry 4.0 in the general context of the global information driven economy.

3.2. Evolving Skillset

Skills and knowledge are crucial for professional advancement and development. Flexible curricula balancing between fundamental field knowledge, technologies based on the latest field updates, and metalearning techniques not only allowing the onoing acquiring of new knowledge but also devising custom plans for achieving so tend to be organized around one or more of the following:

- Experimentation and critical thinking.
- Digital portfolios including online courses.
- Communication and soft skills are included.
- Mentorship tailored for individuals or small groups.
- Balance between global and local needs.

One way, but certainly not the only one, to achieve the above objectives is to structure higher education curricula based on the following recommendations:

- The first year consists of elective courses available from special lists maintained by every department.
- The remaining years consist of elective courses covering a mix of fundamental and current topics.
- Courses can be selected from different departments from the same university or even across institutions.
- Courses can take the form of labs or short-term projects done either individually or in small groups.

A flexible curriculum can give appropriate opportunities to students. For instance, an engineering student may well be allowed to take entrepeneurship and innovation classes from business-related departments allowing therefore a more general education. In addition, wherever possible a lab format should be peferred. In this way, not only theory is put to test and practical skills are gained, but also faculty members have the chance to mentor. Said projects can very well be part of digital portfolios and can be posted in professional networking sites such as LinkedIn[5].

3.3. Connection With Industry

The competition between the major information driven societies with the major powers trying to obtain an advantage in key fields such as robotics, artificial intelligence, omics processing, and space engineering means that knowledge has to be applied in very short time spans. Consequently, companies with a high potential and considerable know-how are in the first line of this competition. In turn, this ultimately translates to an incessant quest for talent with a grasp for systems. The latter can be honed by:

- Industry-sponsored hackathons and projects.
- Practicum placements in companies.
- Skill quizzes from digital carreer sites.
- Dedicated mentorship for industry stakeholders.
- Entrepeneurhip workshops, career days, and portals.

Given the above as well as the requirements of the post-work era higher education institutions should adjust their strategic orientation as they are expected to provide the necessary qualifications for the first and second positions of a recent graduate in order to ensure a good carreer start. At the same time, although good knowledge of the labor market is crucial for gaining an edge, it is no longer the case that said knowledge comes exclusively from universities.

3.4. Distance Learning

With the advent of massive online course (MOOC) platforms such as Coursera[6], EDX[7], Udemy[8], or Udacity[9] which offer a wide array of high quality courses from established universities explicitly customized for a much

5. www.linkedin.com
6. www.coursera.org
7. www.edx.org
8. www.udemy.com
9. www.udacity.com

broader audience, highly personalized digital skill portfolios of tremendous diversity and reach can be built.

In spite of the availability of virtually abundant online matrial, the gradual assembly of such a portfolio is not a trivial task given that for each subject there may well be a plethora of digital courses with very similar titles and descriptions. In this context a mentor or peer recommendations, perhaps in the form of crowdsourcing or or forum conversations, may well offer adequate answers.

The design and delivery of online courses differs from those of traditional university ones in the following aspects:

- The varying background of audience members.
- Asynchronous platform access.
- The peer review assignments.
- Generalized peer interaction.

Distance learning despite the solutions it offers to massive and diverse audiences, it faces the challenges of course and degree recognition from state authorities as well as that of student authentication. However, strong ethics guidelines and codes of conduct tend to mitigate the latter.

3.5. Lifelong Learning

Lifelong learning is another recent innovative educational concept since up until very recently it was widely understood and accepted that systematic education ended with the successful completion of secondary or higher education. Now in the broader context of information driven societies there is no such definite mark. Instead, new skill and knowledge acquisition is a continuous process. The key points of lifelong learning are the following:

- It provides up-to date knowledge for current topics, an important skill in information-driven societies.
- It allows individuals to change their carreer, an emerging trend in many contemporary societies.

In conjunction with distance learning it has created a number of opportunities for interested citizens. Still, certain restrictions should be taken into consideration including the time required to invest in new knowledge, any costs associated with education service providers, and the effort to acquire the background necessary for any new skills.

3.6. Demo Culture

A final trend described here is the shift towards the construction of progressive demos of a system during its development during the time span of a lab. The rationale behind this culture is that frequent demos provide both insight and inspiration from the incomplete model iteself and feedback from the audience. In other words an error is a genuine chance for improvement instead of a drawback, an element commonly found in many existing educational systems worldwide and also recently a focus of intense criticism. Among others the demo culture in higher education offers the following distinct advantages:

- It encourages experimentation and innovation.
- It enables the lab format of many courses.
- It allows frequent progress check.
- It provides a chance for feedback.
- It instills a culture of cooperation.
- It reinforces openess and meritocracy.

However, besides the above advantages there are certain conditions which should be fulfilled. Frist, there should be appropriate infrastructure for the successful conduction of lab sessions and demos including fast and reliable network connections, spare equipment, and dedicated lab personnel. Moreover, a number of mentors should be available to the teams working on the demo. Finally, a demo culture should be in place in order for demos to be successful. This entails giving and receiving tailored, structured, and personalized feedback, as otherwise the latter may well reduce to a mere collection of Barnum statements [56] [57] [58].

3.7. Linguistic Considerations

Local languages in higher education are gradually displaced by English. It is indicative that English expressions including *I will call you back*, *when things go South*, *buy time*, and the *last mile*, are becoming widespread in daily academic talk even though there are local equivalents. This can be attributed to a combination of the following reasons:

- Quickly diffused translations and transliterations.
- More flexible field terminology.
- Increased mobility of academics and scientists.
- Widespread use of English research papers.

New ideas may well require new linguistic schemes as a vehicle. Perhaps a very important example is the rename of the entire field of political economy to economics at the end of 19th century. The driving reason was that during that time the rapid development of econometrics and other quantitative methods radically transformed political economy and made the field look like more mathematics and physics [45].

4. Behavioral Contributions

4.1. Principles

Behavioral sciences rely heavily on a number of underlying principles capturing major aspects of human behavior. The ones most relevant to this work are described in this subsection, although more such principles may well apply up to a certain extent. Notice that some of these principles have been already applied to other fields such as computer science, for instance in social engineering.

The first principle states that individuals strongly correlate concrete and tangible rewards with behavioral changes [41]. Stil tangible does not necessarily translate to material, although this may well be the case, but rather to anything which can be easily identifiable and linked to specific changes. A prime example is the PBL gamification system consisting of points, leaderboards, and badges. These

elements are most commonly associated with the digital realm, even though physical versions thereof can be also found in major events, for instance in sports tournaments.

Principle 1 (Tangible reward). Individuals associate easier behavioral changes with tangible rewards.

Another principle which in fact forms the cornerstone of recommendation engines and of the associated attention economy of social media is that individuals strongly prefer the default option, whenever one is available. In this sense, algorithmically generated recommendations tend to be regarded as objective and reliable and thus it makes perfect sense for them to be added as the default suggestions in any system. This explains, in part at least, the huge popularity of algorithmic recommendation engines [41].

Principle 2 (Default choice). When presented with a number of available options, individuals tend to follow the prespecified one if is suffiently good for their purposes.

The focus of the third principle presented here is the impact of positive feedback over the negative one. In general, encouragement and positive assessment of a trait or a behavior can have a lasting effect on behavior shaping [50].

Principle 3 (Positive reinforcement). Positive feedback on a behavior is more effective than a negative one.

The final principle is about avoid nudging and in general excessive steering towards a desired behavior. It effectively places a cap on the magnitude of positive feedback In this way the brain reward loop is prevented from being saturated. Thus, once the desired behavior of a student is reached, then no further reinforcement is needed [59].

Principle 4 (Mild reinforcement). Constant and visible nudging works against achieving the desired behavior.

The above set of behavioral principles lay an elegant groundwork for developing effective strategies for higher education institutions for either introducing new policies or changing the existing ones. Given the general predisposition for social inertia, namely the power of habit, such strategies allow the seamless transition to a new state while respecting the individual culture of each educational space which encourages or discourages in practice certain policies.

4.2. Strategies

The behavioral principles presented earlier can serve as building blocks for efficiently implementing the elements of the emerging paradigm of section 3. Specifically, possible ways of how they can be applied are explained below and they are also summarized in table 2.

- An evolving skillset can be easier obtained when there are subtle social and professional incentives including open events, smart apps, special purpose leaves, and even peer pressure. Soft encouragement can lead to pervasive campaigns across media maintaining the interest of individuals in developing their skillsets. Moreover, tangible rewards can stimulate this interest, whereas the default choice can help individuals with selecting skills to enhance.
- Lifelong learning can benefit from mild reinforcement since learning is taking place over a long timespan. Therefore, an intense nudge would defeat the purpose and discourage individuals. Additionally, tangible rewards can serve as milestones in the duration of a lifelong learner rewarding consistent and long running efforts. In this way lifelong learners can easily overview their progress and define new objectives for their future endeavors.
- Distance learning is another prime application for behavioral principles. Default choices based on system recommendations can make easier the selection of educational material. Positive reinforcement can come from forums or in general from peer interaction, either generic or personalized, and in conjunction with tangible rewards such as certificates, badges, or discount coupons can stimulate the interest of learners or attract new ones.
- The connection with industry can be also greatly facilitated with tangible rewards taking the form of interview preparation badges or points for attending carreer days or for completing a practicum placement. Also mild reinforcement can make more effective interview reminders or preparation tips. These do not exclude the case that company portals employ more behavioral principles in order to attract new recruits, but this is outside the scope of this work.
- Demo culture finally can tremendously benefit from feedback given directly on the lab site in a manner dictated by positive reinforcement, especially if it comes from a mentor, a lab staff member, or in general a stakeholder since their experience can provide useful insight. Nevertheless, such a feedback should be given in accordance to mild reinforcement in order to avoid the imagination and creativity of the students to be stagnated.

TABLE 2. APPLICATION OF BEHAVIORAL PRINCIPLES.

Trend	**Principles**
Evolving skillset	Default choice Mild reinforcement Tangible reward
Lifelong learning	Mild reinforcement Tangible reward
Distance learning	Positive reinforcement Default choice Tangible reward
Connection with industry	Mild reinforcement Tangible reward
Demo culture	Positive reinforcement Mild reinforcement

4.3. Evaluation

Behavioral analytics have a long history in a number of applications as they play a central role in quantifying the

success of a given behavioral policy and possibly leading to its improvement. They also allow monitoring the deployment of such a policy in almost real time. One of the major objectives of these analytics is determining how the set of students accepting a proposed policy evolves in size.

To begin with, let U be the set of all students and S the subset of students who accept a policy as in equation (1):

$$S \triangleq \{s_1, s_2, \ldots, s_n\} \subseteq U \tag{1}$$

The success probability p_0 is defined as in (2):

$$p_0 = \text{prob}\{\text{strategy success}\} \triangleq \frac{|S|}{|U|} \tag{2}$$

The log-odds ratio λ_0 of equation (3) is a major success predictor over time which can be updated with new data.

$$\lambda_0 \triangleq \ln\left(\frac{p_0}{1-p_0}\right), \quad 0 < p_0 < 1 \tag{3}$$

As S evolves, any two of its instances S_1 and S_2 can be compared with the Tanimoto coefficient defined in (4):

$$\tau(S_1, S_2) \triangleq \frac{|S_1 \cap S_2|}{|S_1 \cup S_2|} = \frac{|S_1 \cap S_2|}{|S_1| + |S_2| - |S_1 \cap S_2|} \tag{4}$$

When S_1 serves as a reference set and S_2 as a variance thereof, then the Tversky index of equation (5) with known parameters α_0 and β_0 should be used instead:

$$\nu(S_1, S_2) \triangleq \frac{|S_1 \cap S_2|}{|S_1 \cap S_2| + \alpha_0|S_1 \setminus S_2| + \beta_0|S_2 \setminus S_1|} \tag{5}$$

5. Conclusions And Future Work

This conference paper focuses on identifying and enumerating current trends on higher education, based on an extensive survey of the relevant scientific literature, and how these can be facilitated with established behavioral principles. As a concrete example, success stories of applying such principles to education and also to other fields are described. Additionally, metrics for result evaluation are given.

This work can be extended in a number of ways. First and foremost, more trends and their respective variants can be mined from the literature or even from interviews with education leaders and stakeholders. Additionally, more refined behavioral analytics can be tailored in order to reach specific audiences or when new data become available. Moreover, results from multimodal learning can be extended to collecting more data from social media, subject to privacy constraints. Finally, reliable long term educational analytics evaluating the level of success of the new paradigm, as was presented here, should be developed.

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