CRITICAL THINKING FROM BIOSCIENCE UNDERGRADUATE STUDENTS’ PERSPECTIVE: A MIXED METHOD RESEARCH STUDY

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Abstract
This paper explores Bioscience Undergraduate (UG) students’ perceptions and understanding of what critical thinking is. The rationale being a gap in the current and past literature on critical thinking (CT): students’ voice is seldom heard; most papers on the topic present the views of academics and not those of students.

The main objectives of this pilot study are: 1) find out what students think critical thinking is in the context of their current and previous studies and 2) assessing CT skills in final year Bioscience UG students.

A mixed method research design was used: quantitative (a standardized survey called Assessment of Critical Thinking Ability – ACTA– devised by White, 2011) and qualitative (focus groups). The rationale for using a mixed method design was to look for a possible relationship between students’ scores in standardized questionnaires measuring CT skills and students’ ideas and perceptions of CT.

Critical abilities tested in the ACTA survey are: 1) integrating studies presenting opposite/conflicting views; 2) designing experiments to resolve uncertainties and ambiguities; 3) imagining possible alternative interpretations to the causes of a Disease X. The survey is designed to generate quantitative data with 4 being the maximum overall score; four questions out of eleven allow for open-ended answers (some of the 480 open-ended answers were also qualitatively evaluated; results will be presented in my Master in Academic Practice dissertation).

Focus groups were carried out with 23 final year UG students in either BSc Biomedical Science or other BSc Programme specification at King’s College London (KCL, UK); they were amongst 127 students who had previously answered the ACTA survey. In the focus groups students participated in activities whose aim was to allow them discussing about their perceptions and understanding of CT, saying how they developed CT skills in schools and at university and if they saw themselves as becoming critical thinkers in science.

Results of this study were the following: 1) an overall combined score of two out of four in the ACTA survey; this score showed that the participating student cohorts, who were almost close to graduation, did not engage critically with the data given to them; in particular, they found hard to design experiments to resolve flaws in studies; 2) findings from the focus groups gave a mixed picture but overall validate the ACTA survey result. They suggest that: students come to university with a variable level of CT and critical analysis skills, if any; many students find hard to clearly explain how CT can be defined and would like to receive a clear instruction from their lecturers on how to develop CT skills; many students do not think developing CT is a top priority in secondary school or at university mainly due to pressures to learn to pass exams via rote learning or Multiple Choice Questions. The students’ perception of CT, which they have developed during their scientific studies, is ‘to spot what is wrong’. In conclusion it can be said that the factual-based syllabus students are mostly exposed in school and at university hinders the development of critical analysis and evaluation of scientific findings. The research findings will enable me and possibly other faculty members to try and find common grounds with the students at the start of the forthcoming academic years, hoping to reach a shared meaning of CT; this in turn will improve academic practice at KCL.

Keywords: students’ perspectives; critical thinking HE, bioscience teaching; ACTA survey, focus groups, mixed method.

1 INTRODUCTION

Critical thinking is a desire to seek, patience to doubt, fondness to meditate, slowness to assert, readiness to consider, carefulness to dispose and set in order; and hatred for every kind of imposture. (Francis Bacon, 1605)
I believe ... that all teaching [in science] on the University level (and if possible below) should be training and encouragement in critical thinking (Popper, 1970)

“Education is not the learning of facts, [...] but the training of the mind to think”
(Albert Einstein, 1921)

Many years of lecturing have convinced me that Popper as quoted above, is correct. Fostering critical thinking and the ability to question received wisdom should be at the core of Higher Education; a primary mission and purpose, which, in my experience, is nonetheless seldom considered a priority in the precious formative years of a Bachelor degree in Science. Over the years I have come to realize that students find extremely difficult to appreciate the controversial nature of scientific findings, tending to accept them as ‘incontrovertible truths’. In my teaching I follow Facione’s [1] definition of truth-seeking, which he sees as “the consistent internal motivation eagerly to seek best knowledge in a given context, to be courageous about asking questions, and to be honest and objective about pursuing inquiry even if the findings do not support one’s self-interest or one’s preconceived opinions” (p9). As Howitt and Wilson [2] argue, in most science degrees, critically analyzing and developing opinions are not fostered with the focus being on delivering factual declarative knowledge; paradoxically, they say, students choose science degrees because of the perceived existence of right and wrong answers; the antithesis of what science should be thought of. This stance is reinforced through the type of teaching university students receive: most of the time they are required to be the passive recipients of talks encouraging them to overlook the importance of questioning in science (and possibly in any other subject) adapting themselves to remember facts and regurgitate them in exams. As Osborne pointed out in a great paper published in Science in 2010 [3], science education is “notable for the absence of argument” (p464). Scientific explanations are given to the students by many countries favor the perceived as “a monolith of facts, an authoritative discourse where the discursive exploration of ideas, their implications, and their importance is absent” [4]. As Karl Popper masterfully writes in his book [5] “The way in which knowledge progresses, and especially scientific knowledge, is by unjustified anticipations, by guesses, by tentative solutions to our problems, by conjectures controlled by criticism, [...] by attempted refutations, which include severely critical tests; [...] criticism of out conjectures is of decisive importance: by bringing out our mistakes it makes us understand the difficulties of the problems we are trying to solve”(p11). If we want to graduate science students that are articulate, capable of critically evaluating information and proposing new solutions I believe that we need to set out to achieve this from the start of students’ education. Very recently McFarlane [6] points out that: “The traditional emphasis on the acquisition, retention and testing of knowledge is no way to promote [...] imagination and creativity”.

Do we really need to invent a new pedagogy? The Socratic method has been shown to be one of the best ways to foster critical thinking [7] and so perhaps we need the application of a type of maieutics in modern university teaching as the norm whereas I see that universities are still types of knowledge-dispensing factories for masses of students. This study therefore sets out to explore the topic of critical thinking within my science teaching, to understand the problems it presents to students so that I can find ways to foster it more effectively.

What is critical thinking and why is it important? We have all told our students at least once: “you need to be more critical” when marking their essays. But what do we mean by this?

The etymology of the word “critical” comes from the Greek “kritikos”, which means “of or for judging, able to discern”. Thinking implies being able to analyze, separating a whole into its parts in order to discover functions, relationships between each component; cogitate; ideate; employ the process of induction and deduction and so forth. Literature on critical thinking is abundant; some of it tries to deal with how best to teach or to assess critical thinking but the overwhelming majority of the literature on critical thinking deals with the scholar perspective on critical thinking skills and/or dispositions, be it philosophical, psychological or educational.

What I have found is a gap in the current and past literature on critical thinking: students’ voice is not heard. We don’t know much about what students understanding of critical thinking is. A few papers have been published which address this particular issue; unfortunately even in these, undergraduate voices are seldom heard. Thus the aim of this research study is to give students a voice and listen to their perspective on critical thinking.
Specific research questions related to this aim are: What is the students understanding of critical thinking? What does it look like in the context of their studies? Do students see themselves as becoming critical thinkers in science? How do they think they develop critical thinking? How important is it to them? Has students university experience so far enabled them to appreciate what being critical means? What previous school experiences of critical thinking do they have? Is there any relationship between student’s scores in standardized questionnaires measuring critical thinking skills and students ideas and perceptions?

The research findings will hopefully increase the level of reflective analysis on my teaching and share with the students a similar meaning of the concept “critical thinking”, enabling better communication and perhaps more effective development of these skills.

2 METHODOLOGY

The project aims require both in-depth exploration of students' views and identification of their critical thinking abilities. I have therefore chosen a mixed-methods design for my empirical research. To define mixed methods we can employ a practical definition given by Leech & Onwugbuzie [8] “collecting, analyzing, and interpreting both qualitative and quantitative data in a single study, or series of studies that investigate the same underlying paradigm” (p 265). Creswell [9] has provided an extensive history of mixed methods research. Pring [10] says: “This subtle interconnection between the public and the private, the objective and the subjective, the physical and the mental, the personal and the social, is too often neglected by those who espouse ‘research paradigms’ which embrace one side of the dichotomy to the exclusion of the other” (p51).

Quantitative and qualitative methods used were: a survey questionnaire called Assessment of Critical Thinking Ability (ACTA) and focus groups.

The ACTA survey questionnaire, composed of 11 questions of which 4 are open-ended, has been ideated; standardized and validated quite recently [11]. The ACTA survey assesses students on three main critical abilities, which have been proven to be fundamental in order to evaluate different lines of evidence. Critical abilities tested are: 1) integrating studies presenting opposite/conflicting views (Questions 4-7); 2) designing experiments to resolve uncertainties and ambiguities (Q8); 3) imagining possible alternative interpretations of the same data (Q9-11). The survey involves three case studies, which are presented to the students each describing methods and data collected to find the cause of Disease X (which is Pellagra but this is not told to the students to avoid them looking it up in the web), no conclusions are given and students need to evaluate the studies. The survey lasts 25 min. Average score on each critical thinking ability assessed was noted following the four-level scoring rubric, which is not published but has been kindly given to me by the author, Dr Brian White (University of Massachusetts). If an answer get level 1 this means students do not engage with the data at all; level 2 they don’t engage the data critically; level 3 they analyze the data critically, including at least one ambiguity and level 4 they critically analyze all of the data. There is no right or wrong answer to the questions asked about the three studies; in each of them there are methodological flaws and/or alternative explanations, which can also be sought. Students need to think critically about the survey material.

Focus groups have been defined [12] as “a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of research” (p499) or [13] “it is a means to set up a negotiations of meanings through intra- and interpersonal debate” (p56).

Focus Groups were carried out to understand students’ views about different aspects of critical thinking. Following Colucci [14], in my focus groups I made use of activity-oriented questions (e.g. listing, sorting, ranking) to provide some structure to support students when discussing a difficult concept such as critical thinking.

Research participants were third year Science undergraduate students and Intercalated Medical students of the School of Bioscience Education in the Faculty of Life Sciences and Medicine at King’s College London. The participants included in the study were a sample of 127 students out of the 150 attending the 3rd year UG Behavioral Sciences module (I am the organizer) and 32 students out of the 100 attending the 3rd Year UG Perspectives on Pain and Nervous System Disorder module (I am the organizer) answered the ACTA survey. Of these, 12 students per module agreed to join the focus groups, with a final a total number of 23 (one student was taken ill).
3 RESULTS

3.1 The ACTA survey

3.1.1 How developed are students’ critical thinking skills?

The students answered the ACTA survey on two separate occasions (Survey 1 and Survey 2). A quick glance at the overall average score (Table 1) shows that a relatively large group of students attending the third year of an UG Science course and close to graduation (a semester left) find quite hard to think about an experiment aimed at solving ambiguities in particular studies (average score being 1.6). A slight improvement in the average scores is shown for Ability 1 (average score being 2.45) and Ability 3 (average score being 2.15); the combined average score of 2 for all the three critical thinking abilities says that the students overall do not engage with the data critically.

Table 1. Average student scores in Abilities A1-A3.

| Ability to conceptualize other interpretations of the same data (A3) |
| Ability to design experiments to resolve flaws in studies (A2) |
| Ability to deal with conflicting data and reach a conclusion (A1) |

Looking separately at the results from the two surveys (data not shown) it is possible to see that students answering Survey 1 did better in Ability 1 and Ability 3 than students answering Survey 2. The differences possibly lie in the different composition of the student cohorts: the smaller group of students (27) who answered survey 1 had a higher percentage of students attending the Perspectives on Pain and Nervous System Disorders while Survey 2 (132 answered) had been answered by a higher percentage of Behavioral Science students, who are largely studying for a Biomedical Science. Students on the Pain module are possibly a more selected group of students who are high achievers or who are intercalating medics who need a high average mark in their first two years of Medicine to be able to attend the 3rd year of a Science degree.

Looking at the more detailed breakdown of the results (Table 2) it is noticed that 52% of the participants in Survey 1 were able to integrate conflicting studies and reach a conclusion analyzing the data critically either including at least one ambiguity or all of the data (Level 3 or 4).
In Survey 2 (Table 3) on the other hand only 17% of the participants were at level 3 or 4 for Ability 1. In Survey 1 18.5% of the participants were at Level 3 for Ability 2 while in Survey 2 only 13% were at the same level in the same ability. Finally in Survey 1, 59% of participants were at level 3 and 4% were at level 4 for Ability 3 and in Survey 2, 46% were at Level 3.

### Table 3. Survey 2 result. Percentages of students (X-axis) answering at the four different levels for each of the three abilities tested

#### 3.2 Focus Groups

#### 3.2.1 Focus groups thematic analysis: themes identified

The process of data analysis led to the identification of main themes. These have been mapped against my research questions in the matrix below (Table 4).
Table 4. Matrix of themes identified in the focus groups discussions mapped against the research questions (CT: Critical Thinking; MCQs: Multiple Choice Questions)

<table>
<thead>
<tr>
<th>RESEARCH QUESTIONS</th>
<th>Theme 1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>What do students understand by critical thinking?</td>
<td>CT relates to analyzing, evaluating, reasoning and having different perspectives</td>
<td>Issues of objectivity vs. subjectivity when exercising judgment; evidence-based argument</td>
<td>Thinking outside the box</td>
<td>Difficulty in constructing an argument in essays</td>
</tr>
<tr>
<td>What does it look like in the context of their studies?</td>
<td>Discussions with class mates Debates (Pain module) Class discussions (Behav Sc module)</td>
<td>Make judgments when writing essays</td>
<td>Extra reading Peer Review</td>
<td>Watching YouTube videos</td>
</tr>
<tr>
<td>How has students’ university experience so far enabled them to appreciate what being critical thinkers mean?</td>
<td>Nature of science teaching (fact-based; rote learning required) not fostering the development of critical thinking</td>
<td>Writing essays; Receiving feedback; Discussing ideas; Listening CT is not very useful to pass exams or MCQs</td>
<td>CT is essential in your career and future life (also the opposite)</td>
<td></td>
</tr>
<tr>
<td>Do students see themselves as becoming critical thinkers in science?</td>
<td>School has not fostered CT skills;</td>
<td>CT as not very relevant in secondary school (the opposite also proposed by grammar/independent school students);</td>
<td>Factual knowledge considered more important at school and at University than CT;</td>
<td>A rounded curriculum fosters CT skills (Grammar school students)</td>
</tr>
<tr>
<td>How do they think they develop critical thinking?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How important is to them?</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>What previous experiences of critical thinking do the students have?</td>
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</tbody>
</table>

3.2.2 What students understand of critical thinking?

In Table 5 I have listed students’ choices of words, which for them best represent critical thinking.

Table 5. This table shows a list of words chosen by the students from a list given to them in the focus groups, which according to them relate more to critical thinking.

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>EVALUATION</td>
<td>ANALYSIS</td>
<td>EVALUATION</td>
</tr>
<tr>
<td>INTELLECTURAL AUTONOMY</td>
<td>REASONING</td>
<td>ANALYSIS</td>
</tr>
<tr>
<td>INTERPRETATION</td>
<td>PERSPECTIVE</td>
<td>ARGUING</td>
</tr>
<tr>
<td>INFERENCE</td>
<td>ARGUING</td>
<td>DEDUCTION</td>
</tr>
<tr>
<td>ANALYSIS</td>
<td>EVALUATION</td>
<td>INTELLECTURAL AUTONOMY</td>
</tr>
<tr>
<td>HIGHER-ORDER THINKING</td>
<td>ANALYSIS</td>
<td>ANALYSIS</td>
</tr>
<tr>
<td>QUESTIONING ASSUMPTIONS</td>
<td>PERSPECTIVE</td>
<td>QUESTIONING ASSUMPTIONS</td>
</tr>
<tr>
<td>ANALYSIS</td>
<td>REASONING</td>
<td>PERSPECTIVE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>REASONING</td>
</tr>
</tbody>
</table>

The words: “Analysis (6)” “Evaluation (3)” “Reasoning (3)” and “Perspective (3)” were overall those most commonly associated with Critical thinking.
The overall impression was that the students were not used to this type of activity, where they had to discuss word meanings between them; the majority had a limited understanding of the terms proposed and a few were leading the discussion when it came to choose critical thinking-related words. Due to word limit I cannot show transcripts of the long discussions between students.

3.2.3 How has students’ university experience so far enabled them to appreciate what being critical thinkers mean

According to this group of students, the university experience enabled them to appreciate what being critical thinker mean mostly by participating in discussion and debating with classmates rather than through formal teaching. Both my modules were mentioned as examples where the students have experienced the benefits of group interaction in the form of class discussions and debates being formally assessed. Students agreed with the following statement made by one of them: “Debating…what we have been doing in this course!! You have a critical debate, discussion in the group; breaking down ideas, problems; questioning; challenging received wisdom…this is being critical and that has helped us to develop [this skill]”. The majority of students in my focus group also mentioned that doing extra reading (and reading for fun!), especially when combined with Journal-led teaching, enabled them to appreciate what being critical thinker meant. Some students also agreed that Peer Review had a similar effect. Contrary to what I would have expected, Lab projects got less votes than for example YouTube videos! I was told that this was because most projects involve learning a lot of technical details but rarely do students get to understand or think about the project’s bigger picture or scientific theoretical framework.

3.2.4 Do students see themselves as becoming critical thinkers in science? How do they think they develop critical thinking? How important is to them?

When thinking about becoming critical thinkers in science, most students were skeptical about this due to the nature of science teaching received during most of their time at university (and at school), which was mostly factual and encouraging rote learning rather than active and critical thinking. A student points out that: ‘We sit in lectures for hours on end listening to lots of scientific facts, every detail in the slides counts and we know we need to remember all of them for the exams’. In terms of how students think they personally develop critical thinking, a wide range of options were commonly cited, ranging from writing essays, getting feedback, reading a lot, discussing ideas and never accepting anything without questioning, listening (to other people’s opinion, reading, watching TV, radio). In terms of how important developing critical thinking is for the students, they mentioned that it was essential for becoming a scientist and for their career more generally: “these days there is so much competition for jobs that you need to be a critical thinker”. Some of the comments show anxiety towards the future and the recognition that critical thinking is something, which could put you ahead in the race toward getting or changing a job. On the other hand most students agreed that critical thinking was not essential to pass exams (although a few students said that it was needed to get high marks) and this elicited long discussions amongst the students.

3.2.5 What previous experiences of critical thinking do the students have?

To my question: “How did you develop Critical thinking in school” one student replied: “stop assuming that students already have Critical thinking [when they arrive at university]”. A few students from grammar schools agreed that having had a full curriculum, which combined both science, arts and humanities subjects gave them a broader perspective in life; others agreed that having attended an independent school they had been “in a teaching/examining environment, which rewarded critical thinking and intellectual autonomy”. The minority of students who had done an International Baccalaureate thought that the Theory of Knowledge module they had to attend did encourage the development of critical thinking. Paradoxically many students said that part of the problem of not having had previous experience of critical thinking in school was due to the fact that universities don’t consider it a suitable A-level topic.

3.2.6 Is there any relationship between students’ scores in a standardized survey measuring critical thinking skills and students’ ideas and perceptions?

This question was at the basis for choosing the mixed method approach so that I could integrate qualitative and quantitative data. Findings from the focus groups give a mixed picture but overall validate the ACTA survey results. The combined level 2 score in the ACTA survey shows that these cohorts of students, who are almost close to graduation, do not engage critically with the data given
them. Discussions in the focus groups reveal the problematic nature of the relationship students have towards critical thinking in University and previously at school. Analysis of students’ exchanges while choosing words defining critical thinking revealed that students were never exposed to an explicit discussion of what critical thinking meant during their studies; the minority of students who studied Theory of Knowledge for their International Baccalaureate (IB) and some who have attended a grammar school represented the exception.

4 CONCLUSIONS

Since I started lecturing to undergraduate Bioscience students in a Higher Education Institution in the UK I have been interested in critical thinking and in ways to better foster it amongst this student population. I have then decided that this could have been the topic of research for a Master in Academic practice. The specific aim of the project was decided after having realized that there was a gap in the current and past literature on critical thinking: students’ voice is not heard. We don’t know much about what students understanding of critical thinking is. I have then decided to give students a voice and listen to their perspective on critical thinking while also looking into their critical thinking abilities. Thus a mixed method design was used, quantitative and qualitative: Bioscience UG participants in their 3rd year answered the ACTA survey and then a smaller group participated in focus groups. The justification for using the ACTA survey in my project comes from its application in the field of Science Education. The authors [11] believed that the results obtained assessing students critical thinking skills with the ACTA survey could inform the science teaching community about the need to reduce teaching and assessment of factual scientific knowledge and increase supporting more scientific and critical ways of reasoning.

The results obtained from the scoring of answers to the ACTA survey gave me insight on the general level of critical thinking a group of Bioscience students have in the in third year of university studies. These results show a general lack of critical thinking skills in the student population assessed in this pilot research study. The very high number of answers scored only at Level 2 (meaning that there is no critical engagement with the data) suggests that students have difficulty with a comprehensive analysis of contradictory findings to reach a conclusion based on a critical evaluation of the material. These results have helped me explain problems I have identified in my academic practice. The results obtained pinpoint towards more work that needs to be done in science education. I have very often advocated the need to expose students very early in their undergraduate years to original research papers, analyzing and discussing their findings’ rather than relying on textbooks and lecture-notes. This in turn could support students’ development of a critical attitude in Science. What is lacking is an enquiry-based learning rather than a knowledge-based one. A recent paper by Willard & Brasier [15] presents very encouraging data following the assessment of first year UG Biology students who followed a module entirely primary literature-based. Students newly developed critical evaluation skills allowed them to feel more comfortable with scientific concepts, methodology and terminology.

Findings from the focus groups give a mixed picture but overall validate the ACTA survey results. The majority of participants had a limited understanding of the critical thinking-related terms. This is quite concerning as many of the essay titles given to the students contain such terms (i.e., evaluate, discuss, analyze, etc.,). From the themes and subthemes emerged in the focus group discussions it seems that rarely school and then university education convey how scientific knowledge advances; a false notion of “objectivity” mar students ideas of science and the factual-based syllabus they are exposed to hinders the development of critical analysis and evaluation of scientific findings. The students’ perception of critical thinking, which they have formed during their studies, is ‘to spot what is wrong’. If at times students’ understanding of critical thinking skills was rather confused on the other hand some students seemed well aware of what critical thinking is but discovered quite soon in their education that developing this skill is not deemed essential to pass exams. It is not even considered important for admission at university, as some students said choosing an A-level in critical thinking was not considered an option for that reason. When students were asked how the university experience enabled them to appreciate what being critical thinker mean they said mostly by participating in discussion and debating with classmates rather than through formal teaching. Both my modules were mentioned as examples where the students have experienced the benefits of group interaction in the form of class discussions and debates being formally assessed. The perceived benefit of debates in developing critical thinking is supported by Scott [16], who authored a short questionnaire devised to receive feedback on the introduction of debates in her technology classroom at college. She founds that students “believed that the debates helped them to learn new knowledge, to gain an understanding of the topic and to gain additional knowledge on the subject. Students also
replied that they would rather prepare for a debate than take a test; [moreover] they also thought that debates increased their critical thinking ability’ (p42). Interestingly when discussing ways to develop critical thinking the majority of students mentioned ‘getting feedback’ rather than ‘addressing received feedback’ or reflecting on it. The students in this instance seemed to avoid their responsibility in trying to act on their feedback and adopted a passive approach, as if getting feedback was enough for their personal development as critical thinkers. In terms of previous school experience students said they had variable opportunities to develop critical thinking and many of comments made show the inequality of the school experience in the UK (i.e., independent or grammar schools vs. state schools).

In terms of research findings these will be used in my academic practice to reflect about the level of critical disposition that third year science undergraduate have. I am now more aware about what meaning students give to the concept of critical thinking; I can understand better the reasons behind the perceived difficulty to accept indeterminacy of scientific findings. This pilot study’s results will enable me to try and find common grounds with the students at the start of the forthcoming academic years, hoping to reach a shared meaning of the abovementioned concepts. I am aware that my research findings must be contextualized to our times, our society and our expectations; if educational policy makers have not yet supported the cause of a change in the way we educate our students, we cannot expect them to become critical thinkers. The milieu in which they grow up should foster this disposition from an early age. I also think that the focus of HE should be on having the students’ interests and intellectual development at the core of what we do rather than giving in to the dictate of today’s mass education where every student is a number with attached a good source of income for the universities. This would mean employing more time and resources to develop better strategies aimed at forging intellectually strong and critically skilled graduates via more meaningful teaching and assessment. In the long term the whole of society will benefit from this investment.

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REFERENCES


