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What do K-12 students feel when dealing with technology and engineering issues? Gardner's multiple intelligence theory implications in technology lessons for motivating engineering vocations at Spanish Secondary School

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ABSTRACT
The interest on engineering and scientific studies can be raised up even from the early years of academic instructional process. This vocation may be linked to emotions and aptitudes towards technological education. Particularly, students get in touch with these technological issues (namely STEM) during the Compulsory Secondary Education in Spain (12–16 years old).This work presents a preliminary evaluation of how relevant is Gardner's multiple intelligence theory (MIT) in the teaching–learning process within the Technology Lessons. In this sense, MIT was considered as an explanation variable of the emotional response within the different educational parts (so-called syllabus units, *SU*) in the Technology spanish curriculum. Different intelligence style (IS) will orient the student to a vision of the engineering and technology. This work tries to identify which relationships can be established between IS and specific technology and engineering learning. This research involved up to 135 students were subsequently tested about their predominant (IS) and on the emotions that arouse in them when working with each *SU*. The results were statistically significant and only those with a Logic-arithmetic or Environmental IS were not affected by the *SU*.Best teaching and learning practicesare required for encouraging further engineering studies.

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Technology education; K-12 students; emotions; multiple intelligences theory

1. Introduction

1.1. Technology education and engineering vocation

It is not new the challenge of a lack of engineering and scientific vocations. Moreover, the link between this situation and the non-adequate teaching and learning of technology is a constant concern for engineering teachers (Cantrell and Ewing-Taylor 2009). We agree with Brophy et al. (2008) when they stated out the following:

> Engineering as a profession faces the challenge of making the use of technology ubiquitous and transparent in society while at the same time raising young learners' interest and understanding of how technology works. Educational efforts in science, technology, engineering, and mathematics (i.e. STEM disciplines) continue to grow in pre-kindergarten through 12th grade (P-12) as part of addressing this challenge.

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According to Cantrell and Ewing-Taylor (2009), it is a fact that one of the most important and relevant aspects for making engineering vocations to arise is to get in touch with scientific and technology issues as directly and soon as possible. Many of this methodologies should be implemented from the early years of academic life, including K-12 and K-16 (Mehalik, Doppelt, and Schuun 2008; Fantz, Siller, and Demiranda 2011). In addition, some authors as Nathan et al. (2013) recently pointed out the relationship between a negative vision of engineering and technology and a fragmented teaching of STEM issues. In the same sense, other authors as Bybee (2011) and Chandler, Fontenot, and Tate (2011) claim for standard methodologies that merge STEM issues in a cohesive way. This evident requrirement for a strong and robust pre-university engineering education also must include the emotional concern, since the implications between the affective domain and the motivation for studying engineering and scientific-related issues is empirically proved either inside the academic space (Matusovich et al. 2014) and outside it (Tang 2013).

1.2. Emotions

Rational mechanisms are undoubtedly in the core of our behaviour, but emotional ones play a vital role that are increasingly taken into account by experts in teaching–learning process . Despite their evident relevance (one remembers with difficult the contents that studied, but it is easy to remember how one felt when studying such topic), the study of emotions and feelings was seen as being far removed from education for many years, and even more so from the teaching and learning of specific school content (Brígido et al. 2013a). Technology contents are even more distant from these considerations, that are recently inserted in the science education corpus (Black and Atkin 2005).

However, as Hargreaves (1998) puts it, *emotions are at the heart of education* (558). Emotions and feelings must be included in the set of variables that should be handled by the teacher for improving the development of learning and it is today recognised that the cognitive configures the affective, and vice versa, and the idea of teaching and learning as an emotional practice in which cognitive and affective processes take part is fully accepted by researchers and educators (Brígido et al. 2013b).

Otero (2006) notes that there is no human action without an emotion that substantiates it and makes it possible. Emotion is central to decision making (Damasio 1996). For pupils, decision making becomes especially important when, at the end of their compulsory education, they have to decide on the direction of their future studies (Lavonen et al. 2008), hence the importance of adequate managing of emotions in order to encourage or discourage future vocations. Numerous studies have found that the attitudinal and emotional factors involved in learning science become increasingly negative with age, especially during secondary school (Marbá-Tallada and Márquez 2010; Vázquez and Manassero 2011).

Consequently, it is not unsafe to affirm that the decline in vocational careers in science and technology in many countries may be related to the adverse emotional context surrounding science and technology learning at school (Vázquez and Manassero 2007). The decrease of these engineering and scientific vocations is a confirmed fact that will have economical implications. Rocard et al. (2007) alerted about how european society, with a knowledge-based economy, can be endangered if the number of students that are interested in these topics continues decreasing.

From theoretical framework of conceptual change and pupils' alternative ideas, Pintrich, Marx, and Boyle (1993) question *cold change*, and argue for the importance of motivation and the emotions as determinants in learning. Positive emotional states favour learning, while negative emotional states severely limit the ability to learn (Vázquez and Manassero 2007). Conceptual change is therefore both cognitive and affective (Thagard 2009) and teachers who ignore the affective aspects of learning may limit their pupils' conceptual change (Duit, Treagust, and Widodo 2008).

According to Manassero (2013), emotions must be included in the attributional models in order to link motivation, emotion and academic performance. It is clear and known that each student feels in a different way if he/she perceives success or failure. Positive emotions will increase the academic efforts and the self-confidence, while no success appreciation would lead him/her to scholar drop (Weiner 1986). It is remarkable that there is no totally *negative* emotions since anxiety could be a motivational force, but it could also block the student, even within adults (Goleman 1996). Hence, a student can be blocked if facing emotional situations such as frustration, wrath or impotency inside or outside the scholar class. As Vázquez and Manassero (2007) pointed out, positive emotional states favour learning, while negative emotional states severely limit the ability to learn.

The relevance of emotions as activators of learning process has been poorly taken into account and almost no academic literature is found in the field of Technology education in Secondary School (Hill and Smith 1998). Previous research indicated the need for analysing the emotions by distinguishing the different subjects of science and technology (Vázquez and Manassero 2007). Other studies show that secondary pupils have positive attitudes and emotions towards Biology and Geology and negative ones towards Physics and Chemistry (Marbá-Tallada and Márquez 2010; Borrachero et al. 2011; Brígido et al. 2013a). Even more, some studies pointed out the need for experiences technology-related in the early years of K-12, such as Mooney and Laubach (2002) made with 5th grade pupils. This study refers a full-immersion experience that links inquiry-based learning and positive emotions.

It is also remarkable the fact that the active assumption of the technology at emotional level is absolutely essential in the integration of these contents and, consequently, a technology learned under negative feelings will be unuseful for learners, either young or adult pupils (Straub 2009). The vision of the engineering exercise itself can be affected by a negative experience (Capobianco et al. 2011).

1.3. Multiple intelligences theory

Gardner's theory of multiple intelligences (Gardner 1983a, 1983b) does not limit intelligence to its purely cognitive facet (Gardner 1995), but takes account of its affective and emotional sides. The intelligence style (IS) of each subject is obviously relevant for designing the different learning strategies, but perhaps a twist on this could be the identification of the emotional performance of each subject according to his/her IS. This information will be useful for complementing the teaching process by considering the emotional response and consequently giving the student an opportunity to improve his/her academic performance. This was also reported by Gardner (1989) in the early years of the multiple intelligences theory (MIT) and this fact has been confirmed by other researchers (Al-Balhan 2006).

Since Gardner set out his theory, many studies have been focused on the estimation of the prevalent thinking style (Furnham, Wytykowska, and Petrides 2005), but there exists a general consensus inside the scientific community on the adoption of different mechanisms for measuring the intelligence of the individuals, mainly by considering this measure as a way of enhancing one's own development rather than imposing certain limits to either personal and academic growth (Almeida et al. 2010).

The use of MIT inside the academic field as a teaching path for enhancing student's capabilities have been previously reported in some published papers with general purposes (Armstrong 2009) or particular ones, that is, focusing the science and mathematics education (Karamikabir 2012).

1.4. The technology syllabus in secondary school. The Spanish case

The current work is made on the basis of the syllabus of Technology lessons in Secondary School in Spain. This is structured in 7 so-called *syllabus units* (SU) that are: Problem resolution (1), Hardware and Software (2), Technical Use Materials (3), Communication and Expression Techniques (4), Structures and Strains (5), Electricity (6) and Information Technologies (7). This structure is consigned in the Regional Government's Instructions for the Technology Subject in Secondary School (Extremadura 2007). These topic is subjected to the current Educational Law in Spain (Espana 2006) and will be changed soon (Espana 2013). However, the main SU in the case of Technology Lessons are kept inside the new educational framework.

1.5. Research target

It is more than evident that, despite its relevance in the education process, Gardner's MIT is not currently included in the regular educative system. The prevalent IS of each student is not a standard aspect to care of in the instruction process, whatever the topic is, even less if we talk about science education. The working hypothesis of this paper is teachers should adapt (at least partially) their instruction methodologies to include students' IS if they want to enhance the knowledge acquisition and, above all, the emotional performance. Some authors have pointed out the relevance of including MIT in the general orientation of academic Science and Technology lessons (McKenczie 2005). In the same researching line, the current work has the objective of identifying and measuring positive and negative emotions within the students of Secondary School in Technology Lessons. We will try to answer the following questions:

- Does the prevalent IS affect to the learning process of the different SU in teaching technology?
- Are some SU more accessible to the global group of students, whatever their prevalent IS is?
- Can Multiple Intelligences Theory be applied to enhance the teaching–learning process of technology, including the students' emotional performance?

Graphically, and for more clarification, Figure 1 presents the relationships between these concepts and the research questions. We are interested in knowing how the different IS respond to the standard teaching method when talking about Technology. This will be done by crossing the results of emotional performance of each subject and his/her prevalent IS. Furthermore, these results can be segmented by SU and evaluate the influence of each one on every subject. The expected results will lead us to recommend the teacher to take special care of those students that will find more difficulties in following the technology lessons just because of their IS, or to identify which SU should be more difficult in a global way for the large majority of the students, since adapting the teaching methodologies drives to a better learning experience, not only on knowledge acquisition, but also on emotional performance.

When talking about *emotional performance* we are defining a variable which is measured by the first questionnaire (see Section 2.1). This gives us a reasonable idea of how good was the students' emotional experience when facing each SU. As can be seen below, these variables is built up taking into account our own expertise.

2. Methodology

2.1. The questionnaires

The scope of this work merges two fields: the student's emotional response facing a whole topic (Technology), although this was segmented in Syllabus Units (SU); and the cognitive attitudes of each student according to Gardner's Multiple Intelligence, that is, the IS. For identifying either the IS and a emotional score of each SU, we have developed three tests that are included as Supplementary Material.

In the case of the emotional score for each SU, the questionnaire was made *ad hoc* (Test 1). In it, students were asked to write down what emotions feel when doing a particular task related with each SU and the reasons for that. For example, when asked about the feelings when handling an automatic

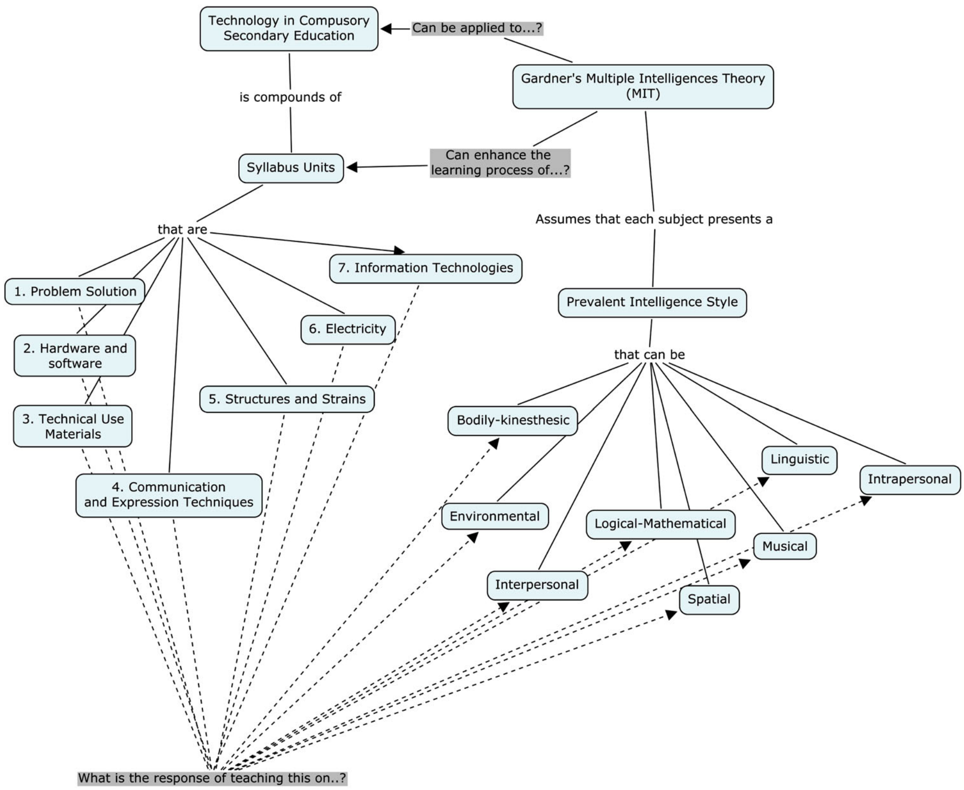

Figure 1. Concept map for the current research. On shadow bubbles we present the research questions.

drill, a student could answer 'fear' because 'perhaps my colleagues could laugh of me'. The answer choices, regarding the involved emotions, were Wrath, Sadness, Boredom or Shame (negative ones) and Happiness or Surprise (positive ones). Since each SU contains four questions, the scoring were done by assigning one positive point for each positive emotion. Negative ones were not taken into account (null scoring), so the total score range is 0–4.

The tool for measuring the prevalent IS (Test 2) was adapted from previous works (Armstrong 2009) which were mainly based on Gardner's first approaches (Gardner1983a, 1983b, 1991). The version designed by Giorgis (2007) was used since it shows a wide acceptation amongst the spanish audience (Barrientos Jiménez et al. 2009). In it the student must score in a 0-5 scale of agreement a total of 32 questions about the way he or she learns in an easier way. The analysis of such items should lead us to assign him/her a predominant IS.

Since the learning strategies have been pointed as a relevant aspect to take into account in the success of the teaching–learning process (Grimes 1995), an additional questionnaire (Test 3) about these strategies was developed on the basis of previous international practical works (Honey and Mumford 1986) and some cultural approaches (Román and Gallego 1994). This is also presented in Supplementary material and was used to confirm the actual ascription of each student to his/her prevalent IS. It consists of 40 items that must be scored in a 0–5 scale.

Only those students with a clear agreement in the results of these two last tests were considered inside the representative sample. Those ones with conflictive results of test 2 and test 3 were discarded. These were about 15% of the initial sample.

The three questionnaires were adequately validated and their robusticity and internal coherency were checked out.

2.2. The data collection

For collecting the data sample the questionnaires were distributed within a group of Secondary teachers of a wide geographical area inside the region of Extremadura (Spain). Up to 20 Secondary teachers were in charge of collecting three questionnaire for each student: one for identifying the predominant IS, another based on the learning strategies for confirming this and a last one about feelings and emotions. Only data from valid individuals (those who obtained coherent results between Test 2 and Test 3) were submitted to statistical procedures, so the final study population were 115 students of 13–14 years old (Second Level of Obligatory Secondary Education in Spain, ESO).

2.3. Data analysis

Data analysis was carried out by using SPSS package (SPSS 2005). For the full analysis, three concomitant statistical test were performed subsequently:

(1) Firstly the whole data sample was segmented by IS and statistically significant differences were established considering the seven SU for each IS.
(2) Then, the data sample was re-organised by segmenting it according not to IS, but SU. So we were able to identify which kind of IS is favoured to each SU. These results are complementary to the previous ones.
(3) Finally, the data sample was submitted to a global one-way ANOVA test, without segmentation, so global results can be observed answering the questions: Which IS is globally favoured in Technology lessons and which one is less considered? Which SU is more *student-friendly* with the current teaching strategies and which one makes negative emotions to arise?

Technically, the statistical analysis results were contrasted by using Tukey's Honestly Significant Differences (HSD) with an $\alpha = 0.5$ (confidence *p*-value of 0.05). This is a post-hoc test that takes the data source from ANOVA statistics.

3. Results and discussion

The empirical confirmation of a higher emotional scoring if MIT is taken into account is the expected result of the current work. This should also be useful for supporting wider theories, such as the one reported by Barrington (2004). This author pointed out the goodness of MIT as a tool for making the School even more inclusive, stimulating the adaptation of those students with more academic difficulties. Additionally, the variation in the instruction methodology (making the lessons dynamic and even different for each student) would help in the acquisition of several desired scientific, academic and citizen skills (Li and Tsai 2013). In addition, we found many literary evidences on the relevance of stimulating creativity and problem-facing activities inside the technology lessons. We agree with Lewis (2009) when he stated out that:

> It is evident that the subject *(technology)* provides a variety of avenues by which children can employ cognitive resources not ordinarily taxed by the academic curriculum. Design and problem solving activities challenge children and teachers alike.

As an initial approach to the data results, Table 1 shows the mean Emotional Scoring for each IS, reached in each SU. As can be seen, the minimum value in this set of experimental results is given by the combination Musical and SU 4, where a 0.46 level is obtained. That means the large majority of individuals with a Musical prevalent IS obtained low scores in terms of emotional performance, that is, negative emotions were radically more present than positive ones. On the contrary, the maximum value in this table is give by the combination Spatial and SU 4, with an emotional score of 3.45.

It is relevant that both values are given in the same SU (3, Technical Use Materials), which will be representative of the different behaviour each IS presents when facing the same topic. Apart from this, the whole table only shows a large prevalence of values between 2.5 and 3.5, so descriptive analysis will give us no more relevant data.

In order to overcome this apparent constant *grey* data vision where no conclusions can come through, we have performed some statistical considerations. The first statistical analysis gave interesting results if we assume that the Emotional Scoring of each SU could actually be an emotional response not to the SU itself, but to the instructional strategies followed by the teacher in each SU. Accordingly, the results should be useful to focus which IS must be taken into a special account when teaching each SU and which one could be most favoured when talking of a particular technology topic.

We have segmented the data set according to the corresponding IS and this has led us to identify the favoured IS for each SU. These results are presented in Table 2. As can be observed, *p*-value for 5 of the 8 IS are below 0.05 for the interaction with SU. Only Logical-mathematical (*p*-value = 0.302) and Environmental (*p*-value = 0.324) IS were not affected by the SU variable, that is, students with these prevalent IS emotionally react in similar ways whatever the SU is being taught. The rest of the IS do present significative differences between each SU. If compared graphically (what is done in Figure 2) one can observe that the emotional scoring of Logical-mathematical IS is quite constant (around 2–3 points) while Musical IS presents a more variable scoring. Additionally, this last IS is almost always below the first one.

Table 2 also shows which SU are more suitable to each IS. Each SU is selected on the basis of Tukey's HSD, so it is statistically significant that, for example, Bodily-kinesthesic IS assumes difficulties in learning SU number 2 (Hardware and Software), whereas SU number 3 (Technical use materials) is the most favoured one. There is a coincidence in the difficult of SU 2 for Bodily-kinesthesic and Spatial IS, as well as in SU number 4 (Communication and Expression Techniques, Technical Drawing) for Inter, Intrapersonal and Linguistic IS. SU number 3 is difficult only for Musical IS. This is remarkable because Musical IS present a tendency which is contrary to the rest of IS: SU number 4 is the most favoured one for them, while SU 3 is the less one. This suggests these students should be the target of special teaching interest since they respond to the instruction strategies in a different way than the rest of students.

Secondly, we can segment the data set according to SU. This will reveal how each IS responds to each SU. Table 3 is also relevant for the data analysis. Here we find some interesting data that should be adequately remarked. For instance, at a first glance one detects the fact that SU 1, 3 and 7 did not reached the significant level for Tukey's HSD, although SU 7 presented a significant *p*-value for ANOVA test for interaction with IS. This is statistically feasible since ANOVA is an *ad hoc* test and Tukey is *post hoc* one (SPSS 2005). This means no statistically significant groups can be established within the seven IS in these cases. Perhaps the reason for this can be found in the intrinsic nature of these SU, which are very global and widely integrated in the ordinary tasks of many people. It is difficult to find academic topics where no Problem Resolution (SU 1) must be applied, for

Table 1. Mean emotional scores for each IS and each SU.

	IS							
SU	1	2	3	4	5	6	7	*N*
Logical-mathematical	2.10	3.30	3.20	2.6	3.20	3.20	2.70	10
Bodily-kinesthesic	1.88	1.53	2.12	1.71	1.94	1.94	2.53	17
Spatial	2.91	2.09	3.18	3.45	2.55	2.22	2.36	11
Interpersonal	2.61	2.04	2.83	1.48	2.22	1.96	3.22	23
Intrapersonal	1.81	2.50	3.13	1.75	2.06	2.50	1.87	16
Linguistic	2.75	2.06	2.94	1.38	1.69	1.81	3.19	16
Musical	2.15	2.00	2.64	0.46	1.46	1.46	2.46	13
Environmental	2.44	2.22	2.89	1.78	1.89	1.67	2.44	9

Note: *N* is the individuals of each IS.

Table 2. Statistical results for segmented data according to IS.

IS	*p*-Value for SU	Most favoured SU	Less favoured SU
Logical-mathematical	0.302	N/A [a]	N/A [a]
Bodily-kinesthesic	0.004	3	2
Spatial	0.024	4	2
Interpersonal	0	7	4
Intrapersonal	0.013	3	4
Linguistic	0	7	4
Musical	0	4	3
Environmental	0.324	N/A [b]	N/A [b]

[a]Not applicable. This IS presents the same positive orientation towards the seven SU. No significative differences are observed amongst them. This is coherent because this IS is the most favoured in globally terms, as we will see forward.
[b]Not applicable. No significative differences were found in the emotional behaviour of this IS with any of the 7 SU.

example. If represented graphically, Figure 3, it is easy to appreciate the differences between the emotional scoring in two typical SU: 3 and 5. The first of them corresponds to Technical Use Materials and presented no significant differences in the emotional scoring of the 8 IS (*p*-value of 0.705). The second one corresponds to Structures and Strains topics and Tukey's HSD test was able to identify up to 2 homogeneous groups where the less scored IS was Musical one and the most favoured one was Logical-mathematical. As can be easily appreciated, the mean emotional scoring for each IS draw two lines with different tendency. The first case keeps a more or less constant path (around 3) while the second one is a clear decreasing curve with a minimum in Musical IS (emotional scoring of 1.46 versus 3.20 of Logical-mathematical). This comparison case is relevant because it is representative of the prevalence of Logical-mathematical IS as a favoured thinking frame in 3 of the 4 SU with significant differences according to Tukey's test. On the opposite extreme, Musical IS is the less favoured one in the same percentage. These two IS are the most distant ones, as we will see below. They are the 'extreme values' when talking of IS.

Finally, the emotional evaluation of Technology lessons can be carried out by analysing the global rate of each IS, whatever the SU is. This analysis, under ANOVA test, gave a significant *p*-value (below

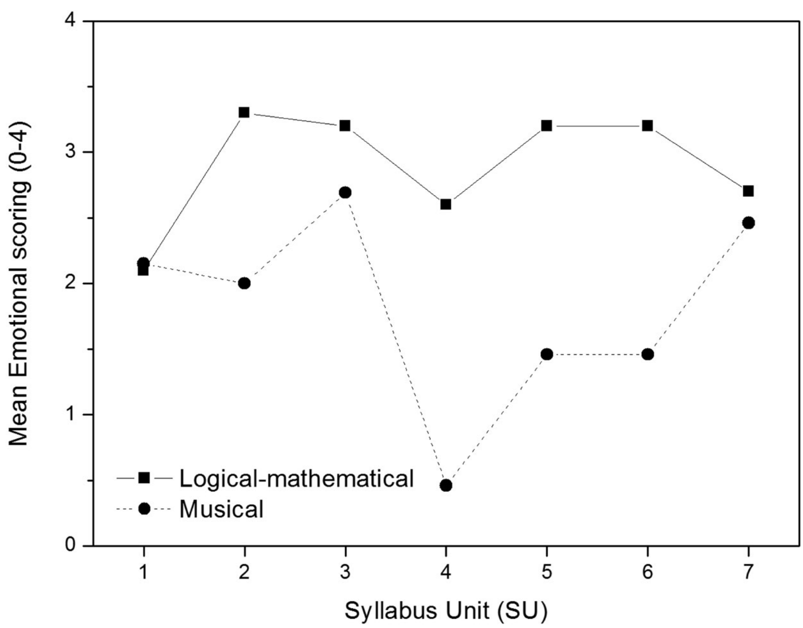

Figure 2. Comparison between the emotional scoring of Logical-mathematical and musical IS in each SU.

Table 3. Statistical results for segmented data according to IS.

SU	*p*-value for IS	Most favoured IS	Less favoured IS
1 – Problem resolution	0.062	N/A [a]	N/A [a]
2 – Hardware and software	0.014	Logical-mathematical	Bodily-kinesthesic
3 – Technical use materials	0.705	N/A [a]	N/A [a]
4 – Communication and expression techniques	0	Spatial	Musical
5 – Structures and strains	0.072	Logical-mathematical	Musical
6 – Electricity	0.072	Logical-mathematical	Musical
7 – Information technologies	0.014	N/A [a]	N/A [a]

[a]Not Applicable because Tukey's HSD presented a not significant *p*-value, so no statistically significant differences can be observed.

0.0001). Levene's test on the variances gave a non-significant result (null hypothesis, *p*-value of 0.739) so the analysis is robust and contrasted. Tukey's HSD confirmed the existence of three groups: the best emotionally-favoured, a intermediate one and the least emotionally-favoured. In agreement with the previous data results, the first group consisted only of Logical-mathematical IS, the third one was constituted of only the Musical IS and the rest of IS were placed in the intermediate group. This is graphically showed in Figure 4.

The reliability of the results from the collected data points out several considerations that are worth mentioning. The first of them, and probably the most important one, is the fact that there exists a general and clear coincidence in placing those students with a prevalent Musical IS in the last positions of the learning process in terms of emotional feelings. This probably means the academic results of these students are lower than the rest of the pupils, although we have no data about the academic performance. However, we can affirm these students will keep worse emotional feelings of Technology lessons and this will influence in their lives. Additionally, we can also affirm that there is not a unique and clear reason for the student segregation we can see in the emotional behaviour inside this topic. The emotional advantage of Logical-mathematical minds may lay not

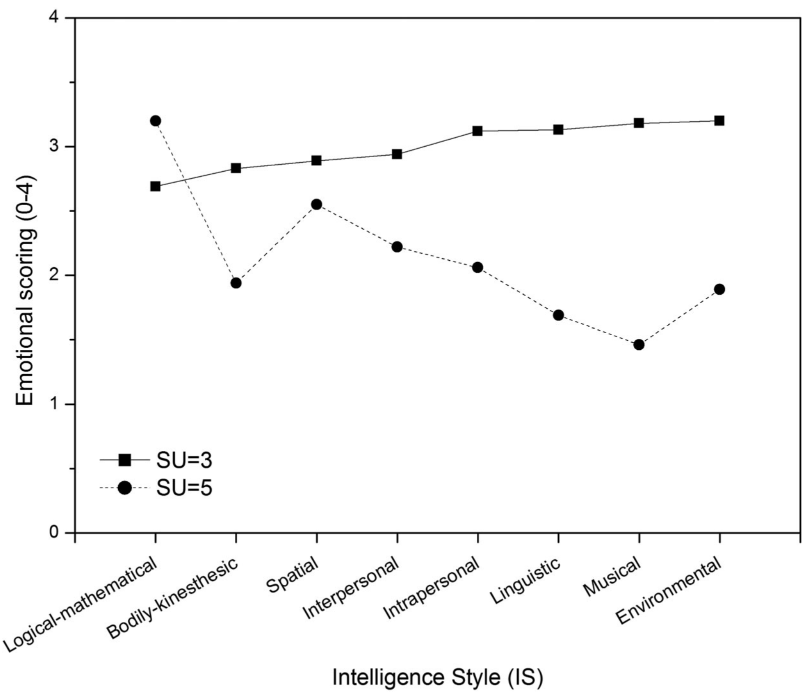

Figure 3. Comparison between the emotional scoring obtained in SU 3 (Technical Use Materials) and 5 (Structures and Strains) depending on each IS.

only in the intrinsic nature of the Technology (what probably affects as well) but also in the instructional strategies the teachers implement in this subject.

Some authors have previously pointed out the adequacy of modelling the instructional strategies according to each student's actual IS in other science areas. For instance, Goodnough (2001) explores this in the context of an action-research group in the High School level and Karamustafaoglu (2010) performed a similar study on university students (prospective teachers) and both founded analogous results that encourage the individualisation of the instruction method, as much as possible. In terms of Primary education, perhaps a good example of research (that also agrees with the two previous ones) is the work signed by Prieto, Ferrándiz, and Ballester (2001) on the Spanish case.

We agree with Sánchez and Llera (2006) when they state the following:

> There exists many few academic scoring systems that consider any other aspects beyond linguistic and logical ones

Accordingly, Prieto, Ferrándiz, and Ballester (2001) also stated:

> MIT uses neutral instruments regarding the intelligence. However, the large majority of psicometric tools are slant towards two ISs: linguistic and logical-mathematical, so the students with these or a combination of both are always favoured.

Our own results in the current work are not focused on the academic performance, which will be the target of further papers, but on the emotional one. In this case, our data confirm either the same tendency Prieto, Ferrándiz, and Ballester (2001) and Sánchez and Llera (2006) pointed out previously and are in agreement with those reported by Ferrándiz et al. (2008), although these authors studied Primary School students.

We also feel confident this study is aligned with the general tendency some authors have already pointed out regarding the role of citizenship building, integral education or, in the words from Snape

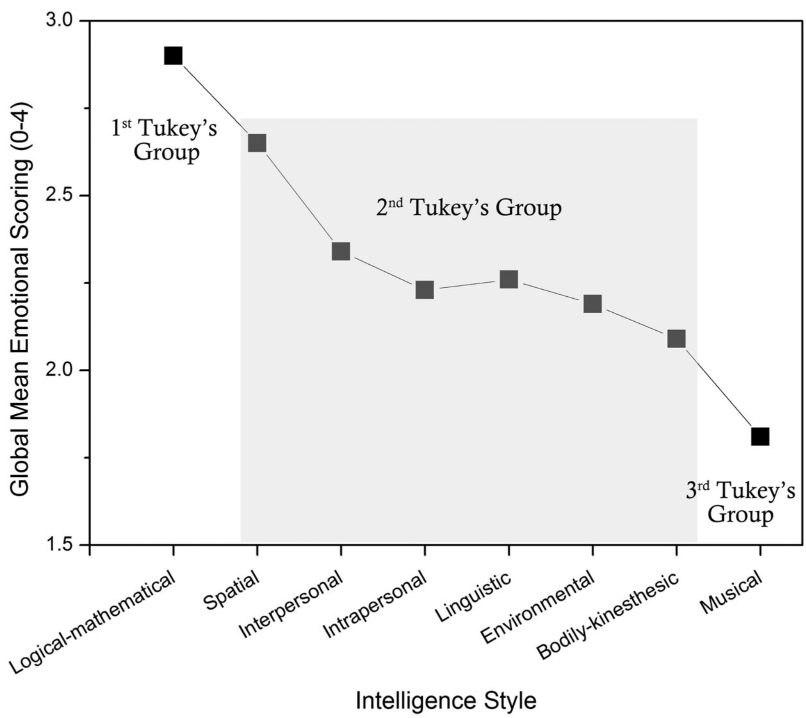

Figure 4. Global mean emotional scoring for each IS in Technology Lessons. Shadowed area delimit the three Tukey's HSD Groups.

and Fox-Turnbull (2013) *authenticity* technology teachers are urged to implement in their daily lessons.

Many other variables could be taken into account in further studies, such as gender, academic marks or age. However, the relevance of including MIT-point-of-view in the teaching and learning process is widely probed.

4. Conclusion

The research questions we stated out in the Introduction section can be answered in the light of the collected data. It is statistically proved that the MIT can be used for explaining differences between students' emotional performance because not every student emotionally reacts in the same way to the same SU. In other words: not every student feels in the same way when facing technology issues, and these differences follow a pattern that has to do with their prevalent IS. Students reacts in different ways when they are subjected to a teaching–learning process and these emotional responses are different enough to take them into account and try to enhance them by adapting the teaching methodologies in view of the emotional responses. Accordingly, teachers are urged to raise the emotional response by promoting positive emotions in the students particularly in those SU with less emotional scoring, that is, Subject Unit 2 (Hardware and Software), 3 (Technical Use Materials) and 4 (Communication and Expression Techniques). It is particularly interesting to see how the same SU can make the best and worst emotions to arise depending only on the prevalent IS: SU 3 is specially attractive to Spatial individuals while is completely disgusting for Musical ones, hence the relevance of taking care of an adequate teaching process that enhance the positive emotions. This will be attempted in further papers. Other prospective studies could also include the gender variable, the age or the academic life.

On the other hand, teachers should take special care of those students with less emotional scoring whatever the SU is, those are the ones with a Musical or Bodily-kinesthesic IS. Since the syllabus content is equal and by-law established, the teachers should take into account these initial data for adjusting their instructional strategies in order to increase the emotional feelings towards Technology of such students and consequently motivate them for developing engineering studies. Further studies could be developed to see if actually changes in the instructional methodologies imply enhancements in the emotional performances of such individuals. Maybe the academic success and the future engineering vocations of these students depend on it.

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