**Abstract**

The aim of this work is to gain a better understanding of the relationship between the emotions that ICTs evoke in students and their assimilation of these technologies. To this end, a quantitative and descriptive methodology based on a student questionnaire was designed for data collection. The results show that ICTs evoked strong positive emotions in the students interacting with them, whose assimilation of these technologies was high. There were positive correlations between the level of assimilation of ICTs and all the emotions experienced by the students. There were also differences in the assimilation of ICTs in terms of the emotions analyzed. Therefore, research on students’ emotional reactions when interacting with ICTs is essential for improving their assimilation.

**Keywords:** ICT; emotions; assimilation; students; school.

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Introduction

The integration of information and communication technologies (ICTs) in schools has a number of benefits including, broadly speaking, improving the quality of the teaching-learning process (Tang, 2021; Moreira-Fontán et al., 2019; Уваров & Uvarov, 2019). Different studies defend the relationship between ICTs and the academic performance of students. In the analysis of the findings of the PISA report, for instance, positive correlations were detected between the frequency of use of ICTs and academic performance (Petko et al., 2017). By the same token, at a professional level ICTs provide students with the additional skills required in a future work environment (Pacheco et al., 2016) and in the new setting to which all workers will have to adapt in the future (Inzunza-Mejia, 2018; Oberländer et al., 2019).

In this connection, the assimilation of ICTs is crucial for the development of competencies that enhance academic and professional performance. The concept of assimilation (along with that of accommodation) has been studied in many areas by the authors of modern classics such as Baldwin, Piaget and Freud. However, its greatest exponent was Vygotski, who understood it as the internal assimilation and construction of an external operation (Álvarez & Sebastián, 2018), contending that all the higher mental functions were social operations that had been assimilated (Becco, n.d.).

In relation to the assimilation of ICTs, the digital gap among students is a relevant issue, as many studies have demonstrated (Bartikowski et al., 2018; Freiman et al., 2018; Jerman & Blažić, 2020; Pérez-Escoda et al., 2016; Schroeder, 2018; Zilka, 2019). So, schools should bear in mind the situation of each student in an attempt to remedy the shortcomings or differences that may arise in the digital environment. Thus, it is essential to raise the awareness of the education community as a whole about the existing barriers, as well as the benefits of ICT assimilation in academic and social contexts, alike (Cabezas et al., 2016; Iglesias et al., 2017).

Emotional reactions when using ICTs

Education, as an interpersonal process, involves the emotions of the stakeholders. Emotions are relevant given that they guide the learning process per se, orientating it towards different content and educational goals. Ergo, they are crucial in education because of the influence that they have on cognitive processes (Du et al., 2019; Lu & Song, 2020; Reid et al., 2016) and their relationship with academic performance (Hinojo-Lucena et al., 2020; Mathrani et al., 2016).

Motivation is a basic element in ICT assimilation associated with the emotional reactions of students. According to Nolasco and Ojeda (2016), motivation is the first step towards digital literacy and a determining factor in accessing technology and interacting with it. In this sense, there is a negative relationship between the feeling of anxiety when using ICTs and motivation, the latter being lower in those students who feel apprehensive when interacting with technology (Zylka et al., 2015). Conversely, those students who experience positive emotions when interacting with ICTs will be more motivated to acquire knowledge or to develop skills (Huertas & Pantoja, 2016; Kim et al., 2014; Zylka et al., 2015).

Self-confidence is one of the most relevant emotions in relation to performance. Confidence in the use of ICTs, namely, an individual’s belief that he or she has the ability to perform tasks requiring their use, is related to a better performance in mathematics and a higher level of scientific literacy, a view endorsed by Zhang and Liu (2016).

Likewise, satisfaction is key to the development of quality learning experiences insofar as it serves as an ideal setting for involving the different stakeholders (Fernández-Pascual, Ferrer-Cascales &
Reig-Ferrer, 2013). On the one hand, student satisfaction is related to engagement and dropping out of school in digital education contexts such as e-learning (Hernández-Chéрез & Tayo, 2017). And, on the other, students who experience greater satisfaction when using ICTs reach higher proficiency levels (Kim et al., 2014).

In relation to the foregoing, another concept studied in the educational context in general is that of emotional or subjective well-being, which is a determining factor in developing active digital citizenship (Jiménez-Cortés, 2016). Subjective well-being is thus associated with students’ perceptions of their own digital skills (De Pablos et al., 2017).

Lastly, it is important to note the relationship between enjoyment and learning. Many learning theories defend the role of games as a key element in the learning process, above all in the childhood stage (García-Puchades & Chiva-Bartoll, 2018). The level of interest in the teaching-learning process is related to the level of gratification that it produces (Mathrani et al., 2016). Accordingly, in the ICT environment there are different experiences involving the so-called ‘serious games’, which include a fun factor in the education process (Barinaga, 2016; Tsekleves et al., 2016; Whalen et al., 2018; Gutiérrez et al., 2018).

**Materials and methods**

The aim of this study is to gain further insights into the relationship between the emotions that ICTs evoke in students at Andalusian primary and secondary schools, with a long track record in implementing best practices in ICT use, and their assimilation of these technologies. It should be noted that when technology is indicated, reference is made to the main ICT available to students, especially computers, Tablets and smartphones. This study is part of a project that analysed more dimensions. In this sense, other publications on the subject can be consulted for further information on the frequency of use of these technologies and their possible impact on the learning process (Llorent-Vaquero, 2020; Rodríguez-López & Llorent-Vaquero, 2015).

To meet the research objectives, a quantitative and descriptive methodology based on an ad hoc student questionnaire or survey was designed for data collection. Specifically, the following objectives were established:

- To describe the emotions felt by students when interacting with ICTs.
- To determine the students’ level of assimilation of ICTs.
- To discern whether or not there is any relationship between the students’ level of assimilation of ICTs and the different emotions resulting from their interaction with them.
- To identify whether or not there are any statistically significant differences between the students’ level of assimilation of ICTs and the different emotions that they experience when interacting with them.

**Sample characteristics**

In line with the study’s general objective, non-probability and purposive sampling (Bisquerra, 2004) was employed, the units of analysis being the schools making up the study sample. To this end, two teachers’ centres in the province of Seville and one in the province of Cadiz were approached to request their collaboration in the selection of the schools according to the following criteria: A long track record in the use of ICTs and the development of best practices in this regard. Following the
selection process, the sample included a total of 18 schools (N=18), which are summarised in Table 1.

Table 1. Description of the study sample

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Preschool centres and primary schools</th>
<th>Secondary schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of schools</td>
<td>18</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>No. of students</td>
<td>1,882</td>
<td>880</td>
<td>1,002</td>
</tr>
</tbody>
</table>

The average age of the students participating in the study was 12.31 (S=2.305), with a minimum and maximum age of seven and 20, respectively. As to the respondents’ sex, 50.8 per cent were boys and 49.2 per cent girls, thus achieving a relatively equal sampling distribution. Likewise, there was a certain degree of parity between the number of primary school (46.8 per cent) and secondary school students (53.2 per cent).

Data collection tool

The questionnaire employed for data collection had two sections: The first including the respondents’ personal data (sex, age, the school’s educational level, etc.) and the second the two measurement scales on which this study focuses. These were five-point (1-5) Likert scales in which the frequency with which the respondents felt particular emotions when using ICTs or performed specific actions relating to the assimilation of their use was determined.

Both scales were developed with the help of a specifications table for the purpose of substantiating the validity of their content. Moreover, reliability and construct validity analyses were performed using Cronbach’s alpha and the factor analysis technique in order to assess the quality of the measurement scales.

Table 2. Reliability and validity of the measurement scales

<table>
<thead>
<tr>
<th>Scale</th>
<th>Reliability</th>
<th>Construct validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotions evoked by ICTs (in the students) (eight items)</td>
<td>0.812</td>
<td>Factor 1 explains the 43.6% variance. All the elements saturate the factor over 0.60</td>
</tr>
<tr>
<td>ICT assimilation (11 items)</td>
<td>0.840</td>
<td>Factor 1 explains the 38.8% variance. All the elements saturate the factor over 0.53</td>
</tr>
</tbody>
</table>

As can be seen in Table 2, the results for both scale reliability and validity guarantee the quality of the measurement tools.
Three statistical analyses were performed on the data: A descriptive one of both measurement scales (measurements and typical deviation); another of correlation between both scales (Spearman); and, lastly, one of contrast so as to determine whether or not there were any statistically significant differences in the level of assimilation of ICTs in terms of the emotions that they elicited (Kruskal-Wallis H test). All the analyses were performed with the SPSS Statistics 24 software package.

**Results**

At a descriptive level, the scale measuring the emotions felt by the students when interacting with ICTs yielded a value of 3.47 (SD=0.907), this being considered as a high score inasmuch as the scale ranged from 1 to 5. The scores for all the scale items are shown in Figure 1.

![Figure 1](image)

**Figure 1.** Average scores for the scale items in regard to ‘Emotions evoked by ICT use’

As shown in Figure 2, the emotions that the students most frequently experienced when interacting with ICTs included curiosity, pride, well-being, satisfaction and enjoyment. In contrast, the emotions least present were a lower level of frustration and the feeling of greater support on the part of the teaching staff. However, it is remarkable how all the scale items received average scores higher than the mean (1 to 5).

As to the extent to which the students assimilated the use of ICTs, the scale mean was 3.31 (SD=0.909), this being regarded as a high value given the range. The averages for all the scale items are shown in Figure 2.
The items that were scored highest by the students were ‘I have no problems with the computer tasks that I am asked to undertake’ and ‘I use the Internet in very different ways to do things that interest me’. In contrast, the least valued item was ‘In class, I have felt the need to use a computer to work, even when the teacher has not envisaged this to perform the task’, followed by ‘I learn things at school that I could not do now without a computer’. However, as with the previous scale, the scores were fairly high bearing in mind that the scale ranged from 1 to 5. Therefore, it can be assumed that the students’ assimilation of ICTs was high.

After creating the unique scale variable, ‘Assimilation of ICTs’, the relationship between this variable and each one of the items of the scale ‘Emotions elicited by ICTs’ was determined. The results obtained in the correlation analysis, employing Spearman’s rank correlation coefficient, are shown in Table 3.

Table 3. Results of the correlation analysis using Spearman’s rank correlation coefficient
<table>
<thead>
<tr>
<th>Description</th>
<th>Correlation coefficient</th>
<th>Sig. (bilateral)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curiosity about the new things that I learn</td>
<td>.360**</td>
<td>.000</td>
<td>1,710</td>
</tr>
<tr>
<td>More support from my teachers</td>
<td>.250**</td>
<td>.000</td>
<td>1,703</td>
</tr>
<tr>
<td>Pride in the things that I do</td>
<td>.389**</td>
<td>.000</td>
<td>1,705</td>
</tr>
<tr>
<td>I do not get frustrated, all goes well</td>
<td>.331**</td>
<td>.000</td>
<td>1,699</td>
</tr>
<tr>
<td>More self-confidence (self-esteem)</td>
<td>.408**</td>
<td>.000</td>
<td>1,700</td>
</tr>
<tr>
<td>More self-assurance, I do not get so nervous</td>
<td>.317**</td>
<td>.000</td>
<td>1,691</td>
</tr>
<tr>
<td>Enjoyment, the things that we do bore me less</td>
<td>.338**</td>
<td>.000</td>
<td>1,699</td>
</tr>
<tr>
<td>Well-being and satisfaction</td>
<td>.408**</td>
<td>.000</td>
<td>1,690</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (bilateral).
In light of the results, it can be claimed, with a confidence level of 99 per cent, that there were statistically significant correlations between ‘Assimilation of ICTs’ and all the variables associated with the emotions evoked by them. Likewise, judging by the coefficient values and significance, the correlation was positive in all cases, albeit moderately so since the values were below 0.5.

Lastly, with respect to possible statistically significant differences in the level of assimilation of ICTs in terms of the different emotions that interaction with them evoked, a contrast analysis was performed using the Kruskal-Wallis H test, whose results are shown in Table 4.

**Table 4.** Results of the contrast analysis between the scale ‘Assimilation of ICTs’ and the emotions elicited by their use
As can be seen in Table 4, the null hypothesis (H0) of equality of means can be rejected as regards all the items associated with the emotions evoked by ICTs, with a confidence level of 99 per cent. Specifically, the differences in the means of the groups in terms of the analysis variable are as follows:

- Curiosity about the new things that I learn: A higher level of assimilation of ICTs in those who are very curious than in those who are less so.
- More support from my teachers: A higher level of assimilation of ICTs in those who feel that they receive a fair amount of support than in those who believe that they receive none.
- Pride in the things that I do: A higher level of assimilation of ICTs in those who feel very proud than in those who feel quite the opposite.
- I do not get frustrated, all goes well: A higher level of assimilation of ICTs in those who feel much less frustration than in those who feel just as frustrated as before.
- More self-confidence (self-esteem): A higher level of assimilation of ICTs in those who feel much more confident than in those who do not.
- More self-assurance, I do not get so nervous: A higher level of assimilation of ICTs in those who feel very self-assured than in those who feel little self-assurance.
- Enjoyment, the things that we do bore me less: A higher level of assimilation of ICTs in those who really enjoy themselves than in those who find little enjoyment in their use.
- Well-being and satisfaction: A higher level of assimilation of ICTs in those who experience more well-being and satisfaction than in those who experience less.

**Discussion and conclusions**

We will now present our conclusions in terms of the established research objectives. As regards the first (to describe the emotions felt by students when interacting with ICTs), the student respondents’ appraisal was positive, thus showing that they experienced positive emotions when interacting with ICTs. The most frequent emotion was curiosity, followed by pride in the things that they did and well-being and satisfaction. This finding is similar to those of other studies that have unscored the importance of satisfaction in the development of key skills (Fernández-Pascual et al., 2013; Hernández-Chérrez & Tayo, 2017; Kim et al., 2014). Conversely, the least frequent emotions had to
do with experiencing little frustration, the support of teachers and self-confidence. These results are in line with the study performed by López-Meneses et al. (2017), in which they note the emotional drawbacks of interacting with ICTs, especially as regards the stress and anxiety that some students may experience.

Moving on to the second objective (to determine the students’ level of assimilation of ICTs), the student respondents’ appraisals were also positive, pointing to a high level of assimilation. This was greater in the items relating to the inter-psychological dimension than in those associated with the intra-psychological one. This demonstrates that the inter-psychological dimension is the first step towards assimilation, to wit, students must be proficient in this dimension before going on to tackle the inter-psychological one (Becco, n.d.).

In relation to the third objective (to discern whether or not there is any relationship between the level of the students’ assimilation of ICTs and the different emotions resulting from their interaction with them), it is possible to observe statistically significant correlations between the assimilation of ICTs and all the emotions experienced when interacting with them. Albeit moderate, this positive correlation points to a clear association between the assimilation of ICTs and the emotions experienced when using them. Thus, it highlights the different emotions that students feel in their interaction with technology (Crisol-Moya et al., 2021; Huertas & Pantoja, 2016; Kim et al., 2014; Zhang & Liu, 2016).

Lastly, as to the fourth objective (to identify whether or not there are any statistically significant differences between the students’ level of assimilation of ICTs and the different emotions that they experience when interacting with them), there were statistically significant differences in the assimilation of ICTs in terms of the emotions analysed. In this sense, a greater positive emotion (pride, well-being and satisfaction, enjoyment, etc.) or a lesser negative emotion (frustration) was associated with a higher level of assimilation of ICTs. This finding is borne out by other studies that associate satisfaction with the development of key skills (Fernández-Pascual et al., 2013; Hernández-Chérrez & Tayo, 2017; Kim et al., 2014).

In sum, the data reflect a clear relationship between the emotions experienced when using ICTs and the level of their assimilation. In other words, students’ emotions are essential in their interaction with ICTs in order to achieve a higher level of assimilation. This conclusion is consistent with those of other studies that defend the importance of emotions for improving educational processes (Hernández-Chérrez & Tayo, 2017; Mathrani et al., 2016; Reid et al., 2016; Neville et al., 2015; Valverde et al., 2013).
References


