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The effect of digital platforms in the motivation of future primary education teachers towards mathematics

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Abstract

Motivation is a key element of daily life. At present, ICTs are considered to be highly motivating elements that are of great importance in all sectors of society. The objective of this research study is to measure and assess the intrinsic motivation level of university students aiming to become Elementary School teachers regarding the use of digital platforms in their math classes. Using the Self-Determination Theory and the Intrinsic Motivation Theory, these students were given a test with 20 questions based on the Intrinsic Motivation Inventory. The results support the conclusion that all participants had a high level of intrinsic motivation, which was highest in students with no previous experience in the use of said resources. It is important to improve, through motivation, the knowledge and skills of future teachers regarding the use of ICTs to enable them to awaken their students' interest in mathematics and facilitate their learning process.

Keywords: Intrinsic Motivation; ICTs; Digital Platforms; Math Classes; School Teachers

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1. Introduction

Since the appearance of technologies, they have rapidly evolved and their presence has spread throughout society. In addition, during the time of isolation experienced in the 2019-2020 school year due to the health emergency caused by COVID19, technologies made it possible to guarantee the continuation of the academic course in many countries. In consequence, there is a growing interest in incorporating them to education as teaching and learning content, and also as a teaching and methodological resource. Several research studies have documented the growing presence of ICTs in different syllabuses (Means and Olson, 1995; Means, Penuel and Padilla, 2001; Sandholtz, Ringstaff and Dwyer, 1997; Schofield and Davidson, 2002; Voogt and Pelgrum, 2005; UNESCO, 2012; Voogt and Roblin, 2013; Kozma, 2003, 2005).

Necessary organizational changes have been made in schools and in classrooms for the integration of information and communication technologies. However, these changes have not been accompanied by technological and pedagogical innovation (Coll, 2008; Area, 2008; Area, 2010; Sutherland, 2004; Balanskat, Blamire and Kefala, 2006; Mendez & Sliko, 2017). At present, the barriers to the integration of technologies in the classroom that have been identified by teachers are the following: lack of training and knowledge regarding ICTs, lack of technical support in the use of said technologies (Keong, Horani and Daniel, 2005; Mendez & Sota, 2017), lack of confidence, competence and resources (Nikolopoulou, Gialamas, 2013; Bingimlas, 2009) and excess workload or lack of time to integrate them (Sang, Valcke, van Braak, Tondeur and Zhu 2010; Keengwe, Onchwari and Wachira, 2008). For Mauri and Onrubia (2008), one of the necessary requirements for the use of virtual surroundings in education is that teachers must positively value the results they can achieve with the integration of ICTs in education, and must know and value the technological tools that can be used in the classroom.

The integration of ICTs in the classroom frequently entails a change in the usual teaching practices, with teachers assuming a certain degree of insecurity and having to look for solutions for the errors that new knowledge can provoke (Jaudenes & Mendez, 2019). Sutherland and his collaborators (2004) classify the different practices with technologies that are developed in the classroom: some are a prolongation of the teaching and learning outlines of books; others try to achieve a balance between individualized learning environments and group learning-teaching in the classroom. Drijvers (2013) highlights three uses of ICTs in math classes: a) ICTs as tools to do mathematics; b) the use of applications as a learning environment for the development of skills; c) the use of applications as a learning environment to work on the comprehension of concepts. Goos (2010) explains that mathematical knowledge is a process of construction starting with the mathematical activity performed by the students through interaction with mathematical ideas, through the relationship with other students or teachers in math learning-teaching experiences or through interaction in a context, situation or problem that may arise from technology. Sarama and Clements (2009), together with Moyer, Niezgoda and Stanley (2005), analyse and document the use of ICTs, concluding that it can provide students with a virtual representation of mathematical concepts and procedures that favour learning, similar to the one produced by the manipulation of didactic materials. Uttal, O´Doherty, Newland and Hand (2009) recommend using virtual representations and at the same time symbolic representations of mathematical objects to support the flexibility of use of mental representations that favour mathematical learning. Radović, Marić and Passey (2019) also suggest using certain digital mathematics platforms in the classroom to carry out tasks in math classes to motivate students and to help teachers analyse better the difficulties that students have with the tasks and their lack knowledge.

1.1. The self-determination theory

The different theories of motivation are considered important in the field of education because of their applications. One of them is the Self-Determination Theory, which enjoys considerable empirical support centred on intrinsic motivation (Pintrich & Schunk, 2006).

The Self-Determination Theory (Ryan & Deci, 2000; Deci & Ryan, 1985) is a theory that describes human motivation and the factors that facilitate or prevent motivation. Individuals have three basic psychological needs: the need to perceive one's own competence, the need for autonomy and freedom, and the need to interact. When one or all of these needs are satisfied, there is an increase of motivation, and when they are not, motivation decreases. The Self- Determination Theory describes and analyses the results obtained in its application in education, sports, work, etc.

Deci and Ryan (2000) recognize intrinsic motivation as something innate to human beings and associate it to conduct that seeks one's own satisfaction, without external or personal pressure and without any instrumental intentionality. This motivation is linked to conducts of exploration, motivated by curiosity or by a playful interest. Deci and Ryan (1985) study the environmental and social factors that can favour or dissuade this motivation. Activities, practices and tasks freely chosen by the individual that are perceived as challenges, as interesting or fun and that promote the perception of one's own competence favour intrinsic motivation (Mendez, Mendez & Anguita, 2018). But some external factors can also help improve this intrinsic motivation, such as messages of positive reinforcement. On the contrary, negative messages or even tangible rewards worsen this motivation. For intrinsic motivation to exist there must be a perception of autonomy; in other words, the individual must feel that he/she freely chooses the task or the practices. When pressure or external control is perceived, intrinsic motivation diminishes. Teachers who support autonomy, who propose challenging activities or practices to their students, and who reinforce their students with positive messages improve their motivation. On the contrary, teachers who are more controlling not only reduced their students' initiative, but also diminish the effective learning, in particular of conceptual content and the development of creative strategies (Amabile, 1996 and Utman, 1997).

Deci and Ryan (2000) describe a variety of intrinsic motivations as a continuum that goes from an unmotivated conduct to the motivation that enables a student to choose and commit to a conduct or practice. This variability of external motivation towards an activity or practice is caused by the type of regulation to which it is subject: external to the individual or interiorized in different degrees. This interiorization of motivation may occur in conduct that seeks to avoid guilt, anxiety or to show the individual his/her capacity, and it is called introjected regulation. The regulation of motivation is considered to be more assimilated when the activity and/or the practice is valued as important for the individual, and it is called regulation through integration. Thus, motivation that results from achievement objectives depending on whether the type of extrinsic motivation is perceived as more externally or internally interiorized affects the level of effort, responsibility, interest and enjoyment. Factors that affect this internalization of extrinsic motivation may be the need for competence, to interact and the perception of freedom linked to the act of choosing.

1.2. Digital e-learning platforms for mathematical education

Wagner (2005) defined e-learning as the educational process that uses information and communication technologies to distribute learning contents, favour communication between students and teachers and manage the different aspects of the learning and teaching process. E-learning enables students to learn at their own speed, facilitating their autonomy. It tends to be interactive; it is independent of the time and space in which the teacher and student find themselves, enabling flexible and accessible learning (Duhaney & Duhaney, 2000; Cabero, et al., 2005, 2006; Baya´a & Daher, 2012).

Through e-learning teachers seek to improve the cognitive and motivation results for learning and to develop skills and strategies to improve learning processes. E-learning has grown, in particular, in formal and non-formal higher education.

Rovai et al. (2007) found that the intrinsic motivation of students taught with an e-learning methodology was greater than that of students taught in a traditional manner. Wan, Wang and Haggerty (2008) conclude that experiences with ICTs and students' virtual competence are two factors that have a positive influence in the use of e-leaning. In a research study involving 2196 students and 29 universities in Austria, Paechter, Maier and Macher (2010) detected two important factors for the success of e-learning: students' assessment of the achievements they can reach as well as the instructor's or teacher's experience and support.

Valentín et al. (2013) studied the use of ICTs and the factors that had an influence on their use with a sample of 534 university students. They obtained a significant coefficient, though with low intensity, that linked the expectations of using ICTs with an improvement of results and satisfaction in study programs that use educational platforms.

Wong, Baars, Davis, Van der Zee, Houben and Paas (2019) present a systematic review about self-regulated learning strategies and suggests focusing on human factors (gender, previous knowledge, level of motivation, etc.) to improve online education through a variety of elements (reinforcement, comments, help, miscellaneous representations, etc.).

In the selection of digital mathematical environments such as digital platforms, understanding mathematical contents, developing skills (problem solving, spatial skills, etc.) and improving motivation to learn mathematics is essential. In order to bring together the opportunities that digital tools offer and the goals of mathematical education (Drijvers, 2020), it is necessary to improve the didactic, pedagogical and technical knowledge of our teachers. Teacher training should include training in the use of digital resources and training in the design of technological tools (Drijvers et al., 2019) to improve the digital competence of future teachers.

2. Method

The objective of this quantitative empirical research study was to determine the motivation of future primary school teachers to use ICTs in their math classes in the future. For this purpose, students of the teacher training university degree program for 2nd and 3rd grades used the digital platforms Khan Academy, Matific, IXL and Smartick for one month, as part of two maths didactics courses. These digital platforms offer exercises, problems, situations and games to learn mathematical contents. In addition, they collect information about the results, time of use and mistakes the students make when they use these platforms that teachers, students and parents can check. The mathematical contents are organized by course and type. In particular, the students focused on the use of platforms for learning and teaching mathematics in primary school and motivational aspects. They performed the activities proposed, reviewed the corrections made by the platforms, their positive reinforcement messages and motivating element, the type of exercises and the representations of the mathematical objects used, considering how they could use digital platforms in the future as teachers. One session was held in the classroom to familiarise themselves with the platforms and to interact. Afterwards, they formed groups of three or four students to perform a practical exercise to analyse the platforms. In January 2019 they were given a questionnaire to measure three dimensions of motivation: 1) the interest and satisfaction with which they engaged in the practical exercise; 2) the mode in which they perceive their competence in the use of these tools, and 3) the value they assign to the use of these platforms.

The sample consisted of two groups of students in the Primary School Teacher Degree Program at a university in Madrid: one group of second year students and a group of third year students. The study was carried out during Didactics of Mathematics I classes with the 2nd year students, and Didactics of Mathematics II classes with the 3rd year students. The sample of the second year students consisted of 43 students, of which 22 had previously used online platforms and 21 who had not. The sample of the group of third year students consisted of 26 individuals, 11 of which had previously used online platforms and 15 who had not. All of them had laptops. In the third year-student group, the average number of hours they used the computer per week was 12, whereas for the second year group the average was 8 hours per week.

2.1. Instrument

The data collection tool is an IMI (Intrinsic Motivation Inventory) questionnaire comprising 20 Likert scale questions with 7 levels to grade the answers: a) 7 questions (2 reverted) to assess the dimension of students' interest and satisfaction in performing the task related to the use of platforms for teaching and learning mathematics; b) 6 questions (1 reverted) to assess how competent students feel concerning this task; and c) a third dimension with 7 questions to evaluate the utility and importance they assigned to the task. Grading went from 1 “Completely disagree” to 7 “Completely agree”.

3. Results

The results of the questions for each dimension are shown below:

Average of the answers of the 2nd and 3rd year students of the Primary School Teacher Degree program to questions regarding their interest and satisfaction in respect to the use of digital platforms for teaching and learning Mathematics

ITEMS	2nd Year Primary		3rd Year Primary	
	Used platform	Did not use platform	Used platform	Did not use platform
1) The task of using digital platforms to learn mathematics was fun.	5.64±1.07	6.14±0.65	5.64 ± 0,88	6.00±0.82
2) During the time devoted to the task of using digital platforms to learn mathematics, I realised that I was having a great time.	5.55±1.20	5.86±1,01	5.36 ±0.64	5.67±1.19
3) I thought that using digital platforms to learn mathematics was a boring activity. (R)	4.50±1.59	4.38±1.68	4.45±1.67	5.27±0.68
4) When I performed the task of using digital platforms to learn mathematics, I thought it was rather fun.	5.41±1.11	5.90±0.70	5.73±0.86	5.60±1.14
5) I did not like using digital platforms to learn mathematics. (R)	5.45±0.89	5.67±0.71	5.45±0.66	5.73±0.44
6) I greatly enjoyed using digital platforms to learn mathematics.	5.41±1.27	5.81±0.87	5.91±0.90	5.47±1.50
7) I would describe the use of digital platforms to learn mathematics as very interesting.	5.45±1.20	6.14±0.73	5.91±0.79	5.87±1.20

The second-year students who had not previously used digital platforms assigned higher scores to each item, compared to those who had used them, except for question 3. Observing the deviations, it can be noted that there is less dispersion amongst the students who had not used platforms than amongst those who had. The two subgroups of second year students assigned the highest score to item 1, and the lowest to item 3. In this dimension, the average number of students who had not used platforms is 5.70, whereas the average number of students who had used platforms is 5.34.

The second year students who had used platforms valued this dimension with a lower score than the other dimensions. In this dimension, the average for third year students is 5.58, a score slightly higher than the one obtained by the second year students, which is 5.52.

A higher average was obtained for each item by the second year students who had not previously used digital platforms than by the ones who had used them, except for question 3. Observing the deviations, we note that that there is less dispersion amongst the students who had not used platforms than amongst those who had. The two subgroups of second year students assigned the highest score to item 1, and the lowest to item 3. In this dimension the average of the students who had not used platforms is 5.70 and the average of the students who had used platforms is 5.34.

Table 2. Average of the answers of the 2nd and 3rd year students of the Primary Teacher Degree program to questions regarding how they perceive their competence in the use of digital platforms as a resource for teaching and learning Mathematics

ITEM	2nd Year Primary		3rd Year Primary	
	Used platform	Did not use platform	Used platform	Did not use platform
8) After using digital platforms to learn mathematics, I felt that I was good at using them.	5.59±0.94	5.95±1.02	6.09± 0.67	5.80±1.05
9) I did quite well using digital platforms to learn mathematics.	5.91±0.79	5.95±1.00	5.82±0.72	5.87±1.09
10) I think that I am quite good at using digital platforms to learn mathematics in comparison with other classmates.	4.50±1.16	4.86±1.09	4.55±1.37	4.13±1.36
11) I was not very good in the activity of using digital platforms to learn mathematics. (R)	5.41±0.65	5.19±1.25	5.09±0.67	5.47±1.02
12) I am satisfied with my performance in the task of using digital platforms to learn mathematics.	5.95±0.88	6.05±0.80	5.82±0.72	5.93±0.68
13) I think I am quite good in using digital platforms to learn mathematics.	5.18±1.23	5.57±0.97	5.45±0.99	5.27±1.00

Once again, the assessment of all items is more positive in the group of second year students who did not use the platforms than in the group that had used them, except for item 11. The average of the students who did not use platforms is 5.64, and 5.41 for the second year students who had previously used platforms. Item 12, namely satisfaction with their own performances, is the one that both second and third year student subgroups valued most. In contrast, item 10 is the one that both subgroups valued less; in other words, they did not value it more than their classmates in second and third year degree studies.

The average of the second-year students who used platforms is 5.41, and 5.47 in the subgroup that had not previously used platforms. However, the subgroup that had previously used platforms valued item 8, which assesses student confidence in the use of platforms after having used them, better in their third year. The average obtained in the second-year sample is 5.53 and 5.44 in the third year, with a slight change of the trend obtained in the first dimension.

Table 1 *Average of the answers of the 2nd and 3rd year students of the Primary Teacher Degree program to questions regarding the value they assign to the use of digital platforms*

ITEMS	2nd Year Primary		3rd Year Primary	
	Used platform	Did not use platform	Used platform	Did not use platform
14) I think that knowing about digital platforms to learn mathematics will help me be a good teacher in the future.	6.14±0.81	6.57± 0.74	6.36±0.64	6.73±0.44
15) I think that performing the activity of using digital platforms to learn mathematics is useful for a teacher's future professional career.	6.14±0.76	6.29±0.77	6.27±0.66	6.53±0.72
16) I could use digital platforms again to learn mathematics because I found it interesting.	5.45±1.30	6.05±0.86	5.82±0.57	5.60±0.88
17) I think that using digital platforms to learn mathematics is important for my future.	5.86±1.01	6.00±0.86	6.00±0.74	6.27±0.93
18) I think that using digital platforms to learn mathematics is an important activity.	5.77±1.08	6.24±0.60	5.82±0.72	6.33±0.79
19) I think that using digital platforms to learn mathematics is beneficial for me.	5.59±1.15	6.29±0.70	6.00±0.85	6.33±1.01
20) I think that using digital platforms to learn mathematics could be valuable for me.	5.68±1.22	6.19±0.65	6.18±0.83	6.27±1.29

The average of the dimension amongst second year students who had used platforms is 5.81 and the average of the second year students who had not used platforms is 6.23. In both groups this dimension obtained the highest score. In addition, it can be observed that the dispersion in the group of students who had not used the platforms is less than in the group that had used them previously. The score for all questions was greater than 6 in the group of second year students that had not used the platforms. The item that was most valued by both second and third year students, in this dimension and all the others, is item 14, namely the importance they attribute to knowing about digital platforms for their future.

In the group of third year students the averages are higher than in the group of second year students. The average obtained among students who had used platforms was 6.06, and 6.30 in the group that had not used them. For second year students, the average of the group that had used platforms was 5.81, and 6.23 for the group that had not used them. This dimension is also the one that was valued best by students. The average obtained for third year students is 6.18, and 6.02 for second year students. Once again, a higher value is obtained by third year students than by second year students.

On analysing whether there were significant differences between the group of second year students who had previous experience with platforms and the group that did not have previous experience, significant differences were found (p=0.038) using the student's t-test with 18 degrees of freedom. However, no significant differences were found between the groups of third year students.

4. Discussion

The results are very positive in both the second and third year groups of students. There are differences of intrinsic motivation between the students who had used platforms to learn mathematics and those who had not previously used them, with a higher valuation of nearly all items by students who had not used platforms previously. Moreover, in the dimensions that assess their competence in the use of platforms, or assess platforms as fun, the scores were slightly lower than the ones obtained in students' valuation of the importance of knowing about platforms.

The results coincide with those obtained by Leung, Watters and Ginns (2005) in a previous study performed with 957 primary school teachers, where the perception of one's skills and knowledge is more valued by individuals who have less experience than by individuals with more experience.

In a research study with 140 fourth year students of the Primary Teacher Degree program that focused on an experience to learn Chinese through games, it was noted that the intrinsic motivation and prior knowledge of Chinese had an influence in the results achieved by students (Baek et al., 2015). Furthermore, both aspects, that is intrinsic motivation and prior knowledge of Chinese, affected each other. In the current research study, the mathematical knowledge that mobilised the students' use of the platforms was at the elementary level, which might also have influenced the motivation reached.

Although prior experience may be a factor that affects motivation in the use of ICTs, research studies continue to show contradictory results. For example, Albirini (2006) studied the attitudes towards ICTs of 320 English teachers in Syria and the factors that conditioned their use. These attitudes were the perception of competence for the use of ICTs and their valuation of ICTs, irrespective of the experience they had in using them.

In a study of 1071 elementary science teachers in Turkey, Cavas, et al. (2009) showed that there were no significant differences between attitudes towards the use of ICTs and gender. However, their results revealed differences considering prior experience with computers, although they were the opposite of the results obtained in this research study.

5. Conclusions

There are several studies on the assessment of ICTs by teachers. However, this recognition has not led to their integration in the classroom, because teachers demand more knowledge of teaching practices with technology and more confidence in the use of technological resources. Nonetheless, due to the recent situation of confinement, the need to integrate technology in the classroom in order to guarantee and improve the learning and teaching processes has become much more relevant in society as a whole, together with the pedagogical and didactic preparation of our future teachers to better use technological tools.

Teacher training and motivation of teachers and future teachers is essential for the integration of technologies in the classroom with pedagogical and didactic criteria. This study shows how the use of activities with technologies in classrooms of primary school teacher degree program students can entail greater motivation for future teachers who do not have previous experience than for those who have had previous experience. Both subgroups, however, assess and consider that nowadays the use of new technologies in the classroom is very important.

5.1. Recommendations

Improving the knowledge and skills of future primary school teachers is a transversal objective during all their years of training. In order to implement this objective, students' motivation must be enhanced, including their assessment of the technologies, the perception they have of their competence and how they feel when they use them. The use and analysis of resources available in primary school classrooms, such as textbooks, material and virtual resources, as well as educational proposals that use the technologies are part of the mathematical training of future teachers (Llinares, 2011; Kearney and Maher, 2013; Szeto and Cheng, 2016; Vlasenko, Chumak, Sitak, Lovianova and Kondratyeva, 2019). The use of virtual platforms specialised in learning and teaching mathematics has been adopted by different primary schools. The results of this study provide grounds to recommend the use of these platforms with future primary school teachers to achieve a more complete training in the didactics of mathematics.

5.2. Limitations

This study has left several lines of research open for the future: one would be to define the effect of the digital platforms in learning mathematics and in learning educational mathematical content.

Another line of research would be to observe, from the student's and the teacher's point of view, the effect of the process of learning mathematics and of student motivation in different dimensions: the interest they have shown in the use of digital platforms, the competence they perceive in the use of these tools, the value they assign to handling these platforms, etc. In addition, we could study how motivation for mathematics can have an influence on the motivation to use these technologies.

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