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**Teachers' acceptance of an open-source, collaborative, free m-learning app:****The predictive role of teachers' self-approach goals**

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**Conflicts of interest**

The authors declare no conflict of interest.

### Abstract

Based on the Technology Acceptance Model (TAM), the aims of the present cross-sectional study were i) to investigate acceptance by teachers of an open-source, collaborative, free m-learning app, named *Artefac*, ii) to examine whether teachers' self-approach goals (i.e., the motivation to teach more effectively than before) may be a relevant external variable to include in the TAM, and iii) to investigate potential differences of acceptance between school subjects (humanities and social science teachers vs. science teachers), status (in-service teachers vs. pre-service teachers), and contexts (teachers in schools classified as difficult vs. teachers in schools not so classified). A total of 419 French teachers (277 women, 142 men) took part in the present correlational survey. After reading a text with pictures presenting an open-source, collaborative, free m-learning app, named *Artefac*, the participants filled out a self-reported questionnaire about its acceptance before use, assessing perceived usefulness for teaching, perceived ease of use, perceived enjoyment, and intention to use. Teachers' self-approach goals were also assessed. One-sample t-tests and structural equation modeling were used to analyze the data. The results showed that *Artefac* was rather well accepted by teachers (with middle to strong effect sizes), whatever their school subject, their status, and their teaching context. The results also highlighted that teachers' self-approach goals positively predicted perceived enjoyment and perceived ease of use but did not predict perceived usefulness for teaching, indicating that the more teachers wanted to increase their teaching skills, the more they found *Artefac* easy to use and fun to use.

*Keywords:* Technology Acceptance Model; mobile learning; pre-service teachers; technology adoption; achievement goals.

## **Teachers' acceptance of an open-source, collaborative, free m-learning app:**

### **The predictive role of teachers' self-approach goals**

#### **1. Introduction**

Many international reports (e.g., OECD, 2015) and governmental measures (e.g., Digital Education Plan which started in France in 2015) encourage including technologies in schools so that teachers and students can take advantage of the potential benefits of these technologies. Among the multitude of types of technologies available on the market, mobile learning (m-learning) now occupies an important place in educational settings (Al-Emran et al., 2018; Sánchez-Prieto et al., 2019), especially since free, open-source, collaborative applications are increasingly being developed. This last type of m-learning seems particularly original and promising for several reasons: i) in a participative and collaborative approach, it is developed by teachers for teachers, ii) it is totally free of charge, therefore easily accessible by teachers and students, and iii) the sharing of resources makes the m-learning application continuously evolving and therefore more and more adapted to the needs of teachers and students.

But the question of technology acceptance by teachers immediately arises and has been a major research topic for many years (for a review, see Scherer et al., 2019). Indeed, even if a technology is objectively effective and accepted by students, it is not automatically accepted by teachers when they are asked to integrate it into their teaching practices. If a technology is accepted by teachers, its likelihood of actual use by the teacher in the classroom increases, which could allow students to reap the benefits of this technology, such as information sharing (Al-Emran et al., 2016) or various learning modalities (Gikas & Grant, 2013). On the contrary, if a technology is not accepted, it will simply be rejected by the teacher and will therefore never be used with the students, even though it could have been

potentially beneficial for their learning (Granić & Marangunić, 2019). Consequently, the first aim of the present study was to investigate the acceptance of a free, open-source, collaborative app by teachers. In addition, teacher characteristics may influence their acceptance of m-learning (Al-Emran et al., 2018; Hoareau et al., 2021; Scherer et al., 2019). In the present study, we compared the acceptance of a free, open-source, collaborative app as a function of teachers' statutory characteristics (humanities and social science teachers vs. science teachers, in-service teachers vs. pre-service teachers, teachers in schools classified as difficult vs. teachers in schools not so classified). We also examined the influence on technology acceptance of a psychological characteristic never investigated in the technology acceptance literature (teachers' self-approach goals, i.e., trying to improve its teaching), while this type of motivational goal has been widely used in the literature on education and teachers.

### **1.1. Definition of m-learning and its adoption in classrooms by teachers**

Due to different types of devices and pedagogical practices, the definition of m-learning is still being discussed (Islamoglu et al., 2021). In a general way, m-learning is an umbrella term for several information and communication technologies that provide education anytime and anywhere (Asghar et al., 2021; UNESCO, 2016). Although laptop computers are considered m-learning devices, tablets and mobile phones are now the most common devices used for m-learning (Crompton et al., 2017). M-learning can be considered a form of e-learning (i.e., electronically supported learning and teaching), but m-learning specifically uses handheld devices and portable technology with anywhere and anytime connectivity (Bakhsh et al., 2017), expanding the potential applications of e-learning (Jung, 2015). The benefits of m-learning are many and varied, for instance individual, situated, and informal learning (Cheon et al., 2012), technological experiences, spirit of collaboration, and information sharing (Al-Emran et al., 2016), variety of ways to learn (Gikas & Grant, 2013), and "helping

students to adapt to the professional needs of a constantly changing world” (Sánchez-Prieto et al., 2019, p.158).

Despite all its promising advantages, the use of m-learning by teachers in a school context remains far below what could have been expected (Moreira et al., 2017). There are several reasons for this: teachers may resist incorporating technologies in their teaching practice (Sánchez-Mena et al., 2017), teachers themselves decide to integrate (or not) a technology into their teaching or their instructional method (Alvarenga et al., 2017; Sang et al., 2010), or they feel that the technology does not meet their needs as teachers or the needs of their students (Teo et al., 2008). In summary, m-learning adoption in classrooms clearly depends on teachers’ intention to integrate mobile technologies into their teaching method (Sánchez-Prieto et al., 2019). Therefore, investigating teacher acceptance of m-learning is a promising avenue to understand why and how m-learning can better penetrate classrooms so that students (and teachers) can benefit from it.

## **1.2. The Technology Acceptance Model in the context of m-learning**

Technology acceptance examines the psychological determinants that may influence the intention to use a technology (Mascret et al., 2022). Acceptance is divided into two categories: acceptance before use (the perception that a person has of a technology before he/she has even used it, sometimes called acceptability, Alexandre et al., 2018) and acceptance after use (the perception that a person has of a technology after using it). This study focuses on acceptance before use because it is necessary to identify if any initial blockages occur as soon as a technology is presented to its potential users, since if individuals do not accept it even before its first use, the probability that it will be used afterwards will be rather low. The final purpose is therefore to understand the psychological mechanisms that could block or delay this adoption from the start.

Several models have been elaborated for studying technology acceptance, such as the Technology Acceptance Model (TAM, Davis, 1989; Davis et al., 1989) or the Unified Theory of Acceptance and Use of Technology (UTAUT, Venkatesh et al., 2003). In educational research and especially in teachers' acceptance of technology, the TAM is the most widely used model (Granić & Marangunić, 2019; Scherer et al., 2019). The TAM is composed of several variables that allow one to question individuals' technology acceptance: Perceived Usefulness, (i.e., "the degree to which a person believes that using a particular system would enhance his or her job performance", Davis, 1989, p.320), perceived ease of use, (i.e., "the degree to which a person believes that using a particular system would be free of effort", Davis, 1989, p.320), and perceived enjoyment (i.e., "the extent to which the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use", Venkatesh, 2000, p.351). These three variables were found to be positive predictors of intention to use the technology. In other words, the more the users find a device useful, easy to use, and enjoyable, the more likely they are to use it.

Several studies have specifically investigated acceptance of m-Learning (for a review, see Al-Emran et al., 2018). Studies examining acceptance of m-learning by students are far more numerous than those conducted among teachers. These have shown that the TAM and TAM-based extended models (e.g., Sánchez-Prieto et al., 2016, 2017) are well-suited for investigating acceptance of m-learning by teachers, confirming that perceived usefulness and perceived ease of use, but also perceived enjoyment, were positive predictors of intention to use m-learning among teachers. But the literature examining acceptance of m-learning by teachers follows the same pattern as the general TAM literature which has investigated acceptance of technologies by teachers in a global way, which results in a reduced number of papers focusing on acceptance of specific technologies (Islamoglu et al., 2021; Scherer et al.,



2019). For instance, Lai et al. (2013) have examined teachers' acceptance of mobile learning using QR codes in outdoor education. But these studies remain rather infrequent because teachers may have difficulty in identifying their levels of acceptance of a general type of technology, m-learning, with which they are not actually familiar (Islamoglu et al., 2021). Asking them about a particular m-learning technology would overcome this barrier by allowing them to identify the real potential of a specific tool for their teaching practice.

### **1.3. The TAM in the context of collaborative, free, open-source m-learning**

In a collaborative m-learning app, the progress of ideas and the improvement of the app itself depend on interaction with others (Maican et al., 2019). In the educational domain, creating interaction between teachers using the same m-learning app may be relevant because teacher collaboration provides benefits for students, teachers, and the school (for a review, see Vangrieken et al., 2015). Furthermore, using free m-learning apps is interesting for schools and students because it does not require a specific budget, which is sometimes limited in some schools or for some students from disadvantaged families. Finally, open-source m-learning allows users to download the source code, to integrate new features, to learn from other users to solve problems, and to improve performance and content (Huang et al., 2020). Digital education using free, open-source tools is currently developing a lot, especially for enhancing collaborative learning (Mohammed et al., 2019). Heradio et al. (2018) even use the expression "open-source movement" to show how popular it is becoming thanks to the community of makers who freely share their creations, which can be studied, modified, and re-distributed, to allow students to explore scientific concepts, to promote their creativity, and to help them to be more comfortable with new technologies.

As a potentially generalizable example, the mobile app used in the present study is called *Artefac*, created by French researchers and available for Android

(<https://play.google.com/store/apps/details?id=com.artefac&hl=fr&gl=US>) and iOS

(<https://apps.apple.com/fr/app/artefac/id1484050522>). It is an open-source, collaborative, free app that allows French teachers in all subjects to create course modules that can be accessed by students anywhere (in class or at home) on any digital device (computer, tablet, mobile phone). These modules can contain multiple resources such as videos, photos, text, recordings, quizzes, augmented reality, 3D images, 360° videos, which teachers can use in their classroom lessons and/or to enable students to work remotely. Based on a collaborative approach, the modules are fed by teachers on a shared database: a teacher who adds a resource related to his/her course makes it available to all other teachers, who can then decide to integrate it (or not) into their own courses. Each teacher can therefore freely download each shared resource individually and/or download complete teaching scenarios mobilizing several resources on a specific theme. *Artefac* makes it possible to put online scenarios developed to be reused as they are or to be modified, thus creating in a participative way a multitude of modules to help students to learn. The *Artefac* database is therefore open to the addition of new resources (videos, 3D images, etc.) offering teachers of all school subjects and all levels the opportunity to integrate it into their own teaching in any way they wish. The present study does not focus on pedagogy, but rather on the acceptance of *Artefac* by teachers. However, using *Artefac* necessarily has consequences on the pedagogy. Indeed, integrating *Artefac* into and outside the classroom leads teachers to refine their skills because *Artefac* offers new ways of interacting to both teachers and students (Pynoo et al., 2011). A collaborative app such as *Artefac* facilitates sharing of opinions, resources, and information between students, between students and the teacher, and between teachers themselves (Dianati et al., 2021). In sum, *Artefac* combines the three characteristics identified above: this m-learning app is collaborative (teachers share their pedagogical resources), free (it is freely available for teachers and students on Android and iOS platforms), and open-source (teachers may modify each teaching scenario).

For all these reasons, examining teachers' acceptance of collaborative, free, open-source m-learning such as *Artefac* seems to be of interest. Few studies have investigated primary and secondary teachers' acceptance of similar apps. *Moodle*, an open-source Learning Management System (Persico et al., 2014), and different online communication and collaboration applications (Maican et al., 2019) have been examined but these studies have been conducted with university teachers. Pynoo et al. (2011) investigated secondary school teachers' acceptance of a digital learning environment (Smartschool), but which does not have the same purpose as *Artefac* since Smartschool is a platform that allows at the same time to make online courses, to be a messaging system for the administration, the teachers, and the students, to propose the schedules of the school online, or to submit online assignments given by the teachers. To the best of our knowledge, no study has yet been conducted with the TAM on a collaborative, free, open-source m-learning application in which all primary and secondary teachers could share with all teachers in the country pedagogical scenarios and teaching resources (e.g., videos, images, text, recordings, quizzes, augmented reality, 3D images, 360° videos). However, the TAM has recently been used with students to examine their acceptance of open-source educational software in general (Racero et al., 2020) and of the open-source software ULearnEnglish (da Silva et al., 2021). Students' acceptance of free and collaborative m-learning apps such as Padlet (Dianati et al., 2021), WhatsApp (Maphosa et al., 2020), or Google Classroom (Ahmed & ur Rehman, 2021) was also investigated. Results of these studies showed that this types of software and app are rather well-accepted by students. But studies focusing on teachers' acceptance of collaborative, free, open-source m-learning are lacking.

Consequently, the first aim of the present study was to examine acceptance by teachers of an open-source, collaborative, free app, namely *Artefac*. Based on the TAM literature investigating teachers' technology acceptance (Scherer et al., 2019) and on the TAM literature

applied to m-learning (Al-Emran et al., 2018; Sánchez-Prieto et al., 2019), we can formulate the following hypotheses:

**H1/H2/H3.** Teachers' intention to use *Artefac* would be positively predicted by perceived usefulness for teaching (H1), perceived enjoyment (H2), and perceived ease of use (H3).

**H4/H5/H6.** Perceived usefulness for teaching would be positively predicted by perceived enjoyment (H4) and perceived ease of use (H5); and perceived enjoyment would be positively predicted by perceived ease of use (H6). H4, H5, and H6 were ancillary hypotheses not directly related to the main purpose of the present study, but necessary to link the TAM variables together based on the relationships already identified in the literature.

**H7/H8/H9/H10.** We hypothesized that scores of perceived usefulness for teaching (H7), perceived enjoyment (H8), perceived ease of use (H9), and intention to use *Artefac* (H10) would be higher than the mean of the scale, indicating that *Artefac* would be well accepted by teachers.

#### **1.4. Extending the TAM in the context of m-learning with self-approach goals**

Since the first works carried out in the field (Davis, 1989; Davis et al., 1989), one of the specificities of the TAM is the possibility of adding external variables to increase its explanatory power. This principle has been implemented in the general TAM literature focusing on teachers, including external variables such as subjective norms, computer self-efficacy, and facilitating conditions (Scherer et al., 2019), and in the TAM literature focusing on m-learning acceptance by teachers, including for instance mobile device anxiety, experience, and user capability (Al-Emran et al., 2018).

Surprisingly, one of the most widely used theoretical frameworks in the field of school education, namely achievement goal theory, has never been used in the educational domain to extend the TAM until now. This theoretical paradigm is based on the principle that the

individual is an organism driven by an intention and is directed by a goal that it implements rationally (Elliot & McGregor, 2001). Achievement goals influence both decision making and behavior of individuals when they are placed in an achievement context, i.e., a context in which individuals' personal competence is assessed, the outcome is up to them, and success is uncertain and socially valued (Elliot et al., 2011). Teaching is carried out in an achievement context because teachers' personal competence is evaluated (by the students, by their colleagues, by the head teacher, by the inspector, by themselves, by the parents), the quality of their teaching depends to a large extent on themselves and their work, the success of teaching is uncertain (e.g., will the lesson go well? will the students succeed?), and is socially valued (being considered a "good teacher"). In an achievement context, an individual's main concern is to demonstrate competence or avoid demonstrating incompetence, which can be operationalized in several ways: comparing oneself with others, and/or progressing in time, and/or mastering the task at hand (Elliot et al., 2011; Mascret et al., 2015). From this point of view, research has focused on the achievement goals pursued by individuals.

In the educational domain, six teacher's achievement goals have been identified (Mascret et al., 2017): task-approach goals (my goal as a teacher is to make my students successful), self-approach goals (my goal as a teacher is to teach better than before), other-approach goals (my goal as a teacher is to be a better teacher than others), task-avoidance goals (my goal as a teacher is to avoid my students failing), self-avoidance goals (my goal as a teacher is to avoid teaching less well than before), and other-avoidance goals (my goal as a teacher is to avoid being a worse teacher than others). A teacher may pursue several goals simultaneously. Among the six teacher's achievement goals that have been identified in the literature, one of them, namely self-approach goals, seemed particularly interesting to examine in the context of the present study. When an individual pursues self-approach goals, his/her own intrapersonal trajectory is the evaluative referent (Elliot et al., 2011): He/she

seeks to do well relative to how he/she has done in the past or has the potential to do in the future, which can be summarized by the expression “doing better than before”. This kind of achievement goal has been identified in many domains such as students’ motivation at school (Elliot et al., 2011) and athletes’ motivation in sport (Mascret et al., 2015). But self-approach goals have also been identified among teachers whose motivation is to teach more effectively than before (Mascret et al., 2017).

While no studies have been conducted to examine the potential predictive role of achievement goals on teachers’ technology acceptance, self-approach goals may be of particular interest as an external variable to include in the TAM, for six main reasons. First, Tang et al. (2021) highlighted that motivational beliefs were often important predictors of intention to use technologies. Achievement goals are considered a form of motivational belief and therefore may influence technology acceptance. Secondly, self-approach goals were positively related to autonomous reasons underlying educational outcomes (Gillet et al., 2017). It is worth noting that autonomy is a major predictor of system acceptance (Liaw et al., 2007) and that the use of m-learning is strongly linked to students’ autonomy granted by teachers inside and outside the classroom (Cheon et al., 2012). Thirdly, resistance to change has been identified as an important negative predictor of technology acceptance by teachers (Sánchez-Prieto et al., 2019). If teachers have a low score on self-approach goals, it means that their motivation is not necessarily to improve as a teacher and therefore they may also have a rather high resistance to change, which could lead them to refuse to use technologies that they have not been using so far. Fourthly, results focusing more specifically on teachers’ achievement goals also showed that teachers’ self-approach goals were found to be positively correlated with intrinsic interest in teaching and with the belief that students’ skills are improvable (Mascret et al., 2017), with teachers’ engagement in their job (Karahana, 2018), and with student motivation, student achievement, relationships with students, and teachers’

sense of personal responsibility (Çetin & Eren, 2022). All these results allow us to think that the probability of using m-learning and especially *Artefac* will be higher among teachers who pursue self-approach goals because they can identify all the added values of *Artefac* for the learning and motivation of their students. Fifthly, self-approach goals were found to be related to online collaborative reflection, which is a process of collaborative critical thinking and knowledge construction (Huang et al., 2021). Therefore, teachers with high self-approach goals might be more interested in the collaborative dimension that *Artefac* allows through the sharing of resources and pedagogical scenarios between teachers. Finally, Peng et al. (2013) showed that creativity was stimulated when teachers develop a learning climate in classrooms focusing on task mastery and personal development, which may suggest that the open-source dimension of *Artefac*, related to creativity, could be of interest to teachers who wish to improve their professional practice (i.e., teachers who have high scores on self-approach goals).

Taken together, all the previous results may suggest that self-approach goals could be positively related with perceived usefulness of a m-learning tool (to improve students' skills and achievement), perceived ease of use (including m-learning would not be so difficult for teachers who are more likely to be committed to their teaching), and perceived enjoyment (teachers with high self-approach goals generally enjoy their teaching more). It is therefore reasonable to assume that self-approach goals may be a relevant external variable to include in the TAM investigating m-learning acceptance among teachers. This was the second aim of the present study, based on the following hypotheses:

**H11/H12/H13.** Teachers' self-approach goals (i.e., teachers' goals are to teach more effectively than before and to improve the way they teach) would be a positive predictor of *Artefac*'s perceived usefulness for teaching (H11), its perceived enjoyment (H12), and its perceived ease of use (H13).

## 1.5. Technology acceptance according to teachers' subject, status, and context

### 1.5.1. Technology acceptance and teachers' school subject

The review of Al-Emran et al. (2018) conducted on m-learning acceptance showed that most studies did not specify the school subject and that humanities / social sciences and sciences were the most represented school disciplines in the studies that specify the school subject. The school subjects were mentioned in this second type of study to characterize the sample only, but the influence of the school subject on the TAM variables was not investigated. A Web of Science literature search did not identify any studies that directly compared scores for perceived usefulness for teaching, perceived ease of use, perceived enjoyment, and intention to use a technology between school subjects, especially humanities and social sciences (e.g., French literature, geography) and sciences (e.g., mathematics, physics). Since *Artefac* is an m-learning app that allows all teachers in different school subjects to produce, collect, and share academic resources, the following hypotheses were made:

**H14/H15/H16/H17.** We hypothesized that scores of perceived usefulness for teaching (H14), perceived enjoyment (H15), perceived ease of use (H16), and intention to use *Artefac* (H17) would not significantly differ between science teachers and humanities / social science teachers.

### 1.5.2. Technology acceptance and teachers' status

In their literature review, Scherer et al. (2019) showed that studies that have investigated invariance of the TAM across pre- and in-service teachers (e.g., Teo et al., 2009) did not often identify a full invariance between these two groups. However, although some relations differed between pre- and -in-service teachers (suggesting moderation effects), they concluded that the generalizability of the TAM is validated among these two subsamples and that the TAM is relevant and applicable for both teacher education (i.e., for pre-service



teachers) and professional development (i.e., for in-service teachers). In addition, it is interesting to conduct studies with pre-service teachers because i) these studies are in the minority in the international literature (Islamoglu et al., 2021), ii) the use of technologies by this specific population has been little investigated in the context of teacher training in France (Impedovo et al., 2016), and iii) pre-service teachers are currently digital natives that use mobile technologies for their own learning during their studies, often in a collaborative manner with their classmates (Lai & Smith, 2018). Consequently, they were more likely to use m-learning in their teaching and we formulate the following hypotheses:

**H18/H19/H20/H21.** We hypothesized that scores of perceived usefulness for teaching (H18), perceived enjoyment (H19), perceived ease of use (H20), and intention to use *Artefac* (H21) would be higher for pre-service teachers than those of in-service teachers.

### *1.5.3. Technology acceptance and teachers' context*

Investigating technology acceptance needs to be considered in a real context of use and implementation (Alexandre et al., 2018). Research on technology acceptance conducted in fields other than education has shown that context can influence TAM variables. For instance, a meta-analysis showed that commercial and non-commercial contexts impacted the TAM variables when investigating acceptance of online services (Wu et al., 2011). In the educational domain, Hoareau et al. (2021) recently highlighted that acceptance of an educational tablet app by teachers of children aged 3 to 6 differed between the teaching context (i.e., the social background of the school). Acceptance of the app was lower for teachers in schools with educational and social difficulties than for teachers in other types of schools. The authors discussed this result by explaining that teachers in schools with educational and social difficulties faced with increased levels of heterogeneity and difficulties that were not necessarily supported by the app. They emphasized the importance of integrating the context and especially the social background of the school when investigating

technology acceptance in the educational domain. This single result in this area then led us to formulate the following hypotheses:

**H22/H23/H24/H25.** We hypothesized that scores of perceived usefulness for teaching (H22), perceived enjoyment (H23), perceived ease of use (H24), and intention to use *Artefac* (H25) would be lower for teachers in schools institutionally classified as difficult than those of teachers in schools not classified as difficult.

In summary, the first aim of the present study was to examine acceptance by teachers of an open-source, collaborative, free m-learning app, illustrated by *Artefac*. Based on the TAM, relationships between perceived usefulness for teaching, perceived ease of use, perceived enjoyment, and intention to use *Artefac* were investigated, as well as the comparison between the scores of each variable and the mean of the scale to highlight the teachers' acceptance levels of *Artefac*. The second aim of the present study was to extend the TAM with teachers' self-approach goals, which seemed to be a relevant variable to increase the explanatory power of the model. Finally, the third aim of the present study was to examine potential differences on the scores of the TAM variables between school subjects (humanities and social science teachers vs. science teachers), status (in-service teachers vs. pre-service teachers), and contexts (teachers in schools classified as difficult vs. teachers in schools not so classified).

## 2. Methods

### 2.1. Participants and procedure

The present study was based on a correlational survey. The sample included 419 French teachers (277 women, 142 men) aged 18 to 62 ( $M_{\text{age}} = 35.48 \pm 10.89$  years) who voluntarily and anonymously took part in the study. The sample included 230 pre-service teachers and 189 in-service teachers. A *t*-test for independent samples showed that years of experience significantly differ ( $t(417) = 34.169, p < .001, d = 3.355$ ) between pre-service

teachers ( $M = 1.01$ ,  $SD = 1.01$ ) and in-service teachers ( $M = 17.86$ ,  $SD = 7.40$ ). Demographics of the sample are presented in Table 1.

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Insert Table 1 about here

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The recruitment period was from October 2021 to June 2022 and met the following eligibility criteria: being a current pre-service or in-service teacher in a French primary or secondary school. Pre-service teachers were recruited during their professional training at the *Inspé (Institut National Supérieur du Professorat et de l'Education)*, which is the French institution that trains future and new teachers. In-service teachers were recruited during training sessions or at their school. Participants filled out a questionnaire about m-learning acceptance before use. Therefore, it is important to note that the participants in the present study never actually used *Artefac*, to identify if any initial blockages occur as soon as a *Artefac* is presented to them according to the following procedure. First, the questionnaire introduces the m-learning app *Artefac* with a short text describing what can be done with it (see Supplementary Material 1) and two pictures of the device (i.e., a screenshot of an augmented reality module presenting the earth/sun rotation, and a screenshot of a text and video module presenting bean germination). Then, participants answered questions assessing the focal constructs (TAM variables and self-approach goals) and questions about general and demographic information. The questionnaire was completed individually, in paper or digital form. Participants' consent was sought beforehand, and they could stop participating at any time without any repercussions.

## 2.2. Measures

### 2.2.1. Acceptance of *Artefac*

Based on the presentation of *Artefac*, participants answered items assessing its perceived usefulness for teaching (e.g., “*This mobile learning device would improve the*

*quality of my teaching*”), its perceived ease of use (e.g., *“It would be easy for me to learn how to use this mobile learning device”*), their perceived enjoyment (e.g., *“Using this mobile learning device in my teaching would be pleasant”*), and their intention to use *Artefac* (e.g., *“If I had easy access to this mobile learning device, I would probably use it in my teaching”*). Each variable was composed of three items, and each item was assessed using a 5-point Likert scale (from *“Strongly disagree”* to *“Strongly agree”*). Items were extracted from previous TAM studies (Mascret et al., 2022; Sánchez-Prieto et al., 2019; Venkatesh et al., 2003) and adapted into French.

### 2.2.2. *Self-approach goals*

Based on the scale validated with French teachers (Mascret et al., 2017), self-approach goals (e.g., *“When I teach, I try to teach better than before”*) were assessed using three items scored on a 5-point Likert scale (from *“Strongly disagree”* to *“Strongly agree”*).

The complete questionnaires are presented in Supplementary Material 1. Internal consistency of perceived usefulness for teaching, perceived enjoyment, perceived ease of use, intention to use, and self-approach goals was validated with McDonald’s omegas (Dunn et al., 2014) ranging from .777 to .916 for the whole sample. The detailed values are presented in Table 2.

Demographic variables were also collected: age, gender, status (pre- or in-service teacher), subject (humanities and social sciences, sciences), and school context (*“In what context is your school located?”* A school classified as difficult / a school not classified as difficult). 29.6% of the sample taught in schools classified as difficult by the French government (combining academic failure, incivility, deviant behavior, social and economic difficulties), which provides them with additional resources to prevent educational failure. Additionally, digital use frequency in class was inquired after with one item (*How often do*

*you use new technologies in your teaching?*) scored on a six-level Likert scale ranging from “Never” to “Very frequently”.

### 2.3. Data Analyses

The JASP software (version 0.16.2) was used for all the data analyses, with a level of significance at  $p < .05$ . First, gross outliers were identified using the Mahalanobis distance ( $\chi^2(9) = 27.88, p < .001$ ) at the multivariate level (In’ami & Koizumi, 2013) and normality of the distribution was identified with values  $\leq |2|$  for skewness and  $\leq |7|$  for kurtosis (Curran, West, & Finch, 1996).

The  $\chi^2/df$  ratio with a value  $\leq 3$ , the CFI (Comparative Fit Index) with a value  $\geq .90$ , the TLI (Tucker-Lewis Index) with a value  $\geq .90$ , the RMSEA (Root Mean Square Error of Approximation) with a value  $\leq .08$ , and the SRMR (Standardized Root Mean Square Residual) with a value  $\leq .08$  were used as fit indices in a Confirmatory Factor Analysis (CFA, Byrne, 2010; Hu & Bentler, 1999). Average Variance Extracted (AVE), composite reliability, and correlations between variables were also used to support the validity and reliability of the instrument. AVE needs to be higher than 0.5 but 0.4 is also accepted when composite reliability is higher than 0.6, identifying that the convergent validity of the construct is adequate (Fornell & Larcker, 1981).

Then, the different hypotheses presented in Figure 1 were tested using a structural equation modeling (SEM) with the maximum likelihood estimation (Everitt & Hothorn, 2011), based on the same fit indices than CFA. A control variable was also entered in the model: frequency of technology use in class. But if this control variable is not found as a significant predictor of one of the model variables, it is removed from the final model in a pursuit of parsimony (Zigarmi, Galloway, & Roberts, 2018).

To examine the level of acceptance of *Artefac*, four consecutive one-sample *t*-tests were used to highlight potential differences between the mean of the Likert scale (i.e., 3) and

the scores of perceived usefulness, perceived ease of use, perceived enjoyment, and intention to use. The same analyses were then conducted for each group: Humanities and social science teachers, science teachers, in-service teachers, pre-service teachers, teachers in schools classified as difficult, teachers in schools not so classified. Cohen's  $d$  was used to calculate effect sizes.

Measurement invariance was tested to investigate whether the same measure was interpreted by different groups in a conceptually similar way, which ensures that subsequent comparisons between groups are valid (Chan, 2011). Following the steps of Putnick and Bornstein (2016), measurement invariance was tested at the configural levels (i.e., the constructs have the same pattern of free and fixed loadings), metric levels (i.e., each item contributes to the latent construct to a similar degree), and scalar levels (i.e., mean differences in the latent construct capture all mean differences in the shared variance of the items). Following the procedure used by Chen (2007), a change  $\leq -.01$  in CFI and a change  $\leq 0.15$  in RMSEA is necessary to validate a step. If measurement invariance was validated, we would be allowed to use  $t$ -tests for independent samples to compare the scores of the variables of interest (perceived usefulness, perceived ease of use, perceived enjoyment, intention to use) between school subjects (humanities and social science teachers vs. science teachers), status (in-service teachers vs. pre-service teachers), and contexts (teachers in schools classified as difficult vs. teachers in schools not so classified). Again, Cohen's  $d$  was used to calculate effect sizes.

### **3. Results**

#### **3.1. Preliminary Results**

The analyses based on Mahalanobis distance showed that no participant was identified as an outlier. Normality assumptions were validated for the full sample because the maximum values of skewness (max = |1.740|) and kurtosis (max = |4.270|) were below the thresholds

defined by Curran et al. (1996). Normality assumptions were also validated for the different groups (humanities and social science teachers, science teachers, in-service teachers, pre-service teachers, teachers in schools classified as difficult, teachers in schools not so classified). All the values for each variable and each group are presented in Table 2.

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Insert Table 2 about here

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### 3.2. Validation of the TAM applied to *Artefac* and teachers

First, the results of the CFA conducted on the covariance matrix of the TAM items supported the hypothesized five-factor model ( $\chi^2(80, N=419) = 120.916, p = .002, \chi^2/df = 1.511, CFI = .990, TLI = .987, RMSEA = .035, SRMR = .028$ ). AVE and composite reliability met the requirements of Fornell & Larcker (1981) for each variable, suggesting that the convergent validity of the construct is adequate. Perceived usefulness for teaching, perceived ease of use, perceived enjoyment, intention to use, and self-approach goals were all significantly correlated ( $.016 < ps < .001$ ). Detailed results of AVE, composite reliability, and correlations are presented at the bottom of Table 2.

Secondly, the results of model fit were in line with the expected requirements ( $\chi^2(3, N=419) = 2.767, p = .429, \chi^2/df = .922, CFI = 1, TLI = 1, RMSEA = .000$  (90% CI = .000-.080), SRMR = .020).

Thirdly, the main results of the SEM showed that teachers' intention to use *Artefac* was positively predicted by perceived usefulness for teaching (H1 supported,  $p < .001$ ), perceived enjoyment (H2 supported,  $p < .001$ ), and perceived ease of use (H3 supported,  $p = .043$ ). The more the teachers found *Artefac* useful, enjoyable, and easy to use, the more they intended to use it during their classes with students. The model predicted 66.5% of the variance of intention to use, but also predicted 50.9% of the variance of perceived usefulness for teaching, 24.8% of the variance of perceived enjoyment, and 2.6% of the variance of

perceived ease of use. The results of the SEM also showed that self-approach goals positively predicted perceived enjoyment (H12 supported,  $p = .003$ ) and perceived ease of use (H13 supported,  $p = .033$ ), but did not predict perceived usefulness for teaching (H11 not supported,  $p = .303$ ).

Fourthly, ancillary results highlighted that perceived usefulness for teaching was positively predicted by perceived enjoyment (H4 supported,  $p < .001$ ) but not by perceived ease of use (H5 not supported,  $p = .900$ ). Perceived enjoyment was positively predicted by perceived ease of use (H6 supported,  $p < .001$ ).

Finally, the control variable, frequency of technology use, was found to be a positive predictor of perceived ease of use ( $p = .019$ ) and intention to use *Artefac* ( $p < .001$ ). Figure 2 represents the final model validated in the present study.

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Insert Figure 2 about here

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### 3.3. Levels of acceptance

The results of the one-sample  $t$ -tests showed that means of perceived usefulness for teaching ( $t(418) = 14.004$ ,  $p < .001$ ,  $d = 0.684$ ), perceived ease of use ( $t(418) = 8.308$ ,  $p < .001$ ,  $d = 0.406$ ), perceived enjoyment ( $t(418) = 17.538$ ,  $p < .001$ ,  $d = 0.857$ ), and intention to use ( $t(418) = 14.741$ ,  $p < .001$ ,  $d = 0.720$ ) were significantly higher than the mean of the Likert scale (i.e., 3), indicating that the teachers who participated in the survey found *Artefac* rather useful for teaching, easy to use, and pleasant to use, and rather intended to use it. Hypotheses H7 to H10 were confirmed. Ancillary analyses were conducted on participants of each group and the pattern was similar than for the full sample. Humanities and social science teachers, science teachers, in-service teachers, pre-service teachers, teachers in schools classified as difficult, and teachers in schools not so classified had means of perceived usefulness for teaching, perceived ease of use, perceived enjoyment, and intention to use significantly higher than the mean of the Likert scale (all  $ps < .001$ ).



### 3.4. Comparison between groups

Invariance across participants from various groups (subject, status, and context) was validated at the configural, metric, and scalar levels (i.e., CFI values change  $\leq .01$  and RMSEA values change  $\leq .015$  for each invariance step and each group). The comparison of scores between participants in different groups can therefore be conducted without any reservations. The results of the  $t$ -tests for independent samples highlighted that: i) no significant differences were found between science teachers and humanities and social science teachers on perceived usefulness for teaching ( $p = .714$ ), perceived ease of use ( $p = .196$ ), perceived enjoyment ( $p = .661$ ), and intention to use ( $p = .751$ ), confirming hypotheses H14 to H17, ii) perceived usefulness for teaching ( $t(417) = 3.587, p < .001, d = 0.352$ ), perceived ease of use ( $t(417) = 2.330, p = .020, d = .229$ ), and perceived enjoyment ( $t(417) = 3.840, p < .001, d = .377$ ) were significantly higher for pre-service teachers than for in-service teachers, while no significant differences were found for intention to use ( $p = .119$ ), confirming hypotheses H18, H19, H20, but not H21, iii) no significant differences were found between teachers in schools classified as difficult and teachers in schools not so classified on perceived usefulness for teaching ( $p = .997$ ), perceived ease of use ( $p = .568$ ), perceived enjoyment ( $p = .978$ ), and intention to use ( $p = .222$ ). Hypotheses H22 to H25 were not confirmed. All the descriptive statistics are presented in Table 2. The results of perceived usefulness for teaching are presented in Figure 3 and the results of perceived ease of use, perceived enjoyment, and intention to use are presented in Supplementary Materials 2, 3, 4. A summary of the validated and rejected hypotheses is presented in Table 3.

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Insert Figure 3 about here

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Insert Table 3 about here

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## 4. Discussion

### 4.1. Validation of the TAM and levels of acceptance

The first aim of the present study was to examine teachers' acceptance of an open-source, collaborative, free m-learning app, named *Artefac*. In accordance with the hypotheses, teachers' intention to use *Artefac* was positively predicted by perceived usefulness for teaching, perceived enjoyment, and perceived ease of use (H1, H2, H3 validated). These results were in line with numerous studies investigating teachers' technology acceptance with the TAM (for reviews, see Granić & Marangunić, 2019; Scherer et al., 2019) and with studies investigating more specifically teachers' m-learning acceptance with the TAM (for a review, see Al-Emran et al., 2018). However, it is difficult to position our results in relation to other apps of the same type as *Artefac* (open-source, collaborative, free, allowing the sharing of different resources between teachers) since we identified in the Introduction section that this type of study was lacking among primary and secondary teachers whereas it existed among students (Ahmed & ur Rehman, 2021; da Silva et al., 2021; Dianati et al., 2021; Maphosa et al., 2020; Racero et al., 2020). Moreover, mean scores of perceived usefulness for teaching, perceived ease of use, perceived enjoyment, and intention to use were significantly higher than the mean of the scale for the whole sample, indicating that the teachers found *Artefac* useful for teaching, easy to use, and pleasant to use, and they intended to use it (H7, H8, H9, H10 validated). These results remained the same when we conducted subgroup analyses by academic subject (humanities and social science teachers, science teachers), status (in-service teachers, pre-service teachers), and teaching context (teachers in schools classified as difficult, teachers in schools not so classified).

Taken together, all these results allow us to affirm that an open-source, collaborative, free m-learning app such as *Artefac* is rather well accepted by the teachers, whatever their characteristics. The availability of course modules that can be accessed by students anywhere

(in class or at home) on any digital device (computer, tablet, mobile phone) may have been considered useful by teachers, while the different formats of the resources (videos, photos, recordings, quizzes, augmented reality) may have increased perceived enjoyment. The shared and collaborative functioning of apps such as *Artefac* may have enhanced perceived ease of use because each teacher can freely download each shared resource individually and/or download complete teaching scenarios mobilizing several resources on a specific theme, which is easy to reuse later with their own students. All these reasons specifically related to open-source, collaborative, free m-learning app ultimately makes teachers more willing to use *Artefac* and the same type of collaborative m-learning.

The two TAM variables that most predicted intention to use *Artefac* were perceived usefulness and perceived enjoyment. This is not surprising for perceived usefulness since on the one hand it is often the case in studies investigating teachers' technology acceptance (Al-Emran et al., 2018; Granić & Marangunić, 2019; Scherer et al., 2019) and on the other hand perceived usefulness is a major variable when studying acceptance of utilitarian technologies (Van der Heijden, 2004), such as m-learning technologies. It is not so surprising either for perceived enjoyment since intrinsic motivational factors also come into play to explain technology acceptance (Davis et al., 1992; Van der Heijden, 2004). This result is in line with those of Sánchez-Prieto et al. (2019) who have pointed out the importance of integrating perceived enjoyment as a determinant of technology adoption and who have made a call to replicate the results of their study focusing on m-learning, which has been done in our own study with *Artefac* which is a collaborative, free, open-source m-learning app.

#### **4.2. Extending the TAM with teachers' self-approach goals**

The results also showed that teachers' self-approach goals positively predicted perceived enjoyment and perceived ease of use but did not predict perceived usefulness for teaching. Our hypotheses were therefore partially validated (H11 rejected, H12 and H13

validated). Three reasons may explain why self-approach goals were found to be significant positive predictors of perceived ease of use (H12). First, self-approach goals were oriented towards outperforming oneself and towards action to do so, encouraging individuals to raise energy and effort (Hulleman et al., 2010). Consequently, teachers following self-approach goals were more likely to think that including *Artefac* in their courses would not be so difficult because they are accustomed to making efforts. Secondly, when a teacher is usually motivated to teach more effectively than before, he/she regularly experiments with new ways of teaching and new tools (Mascret et al., 2017), which makes it easier to develop skills related to the integration of new devices such as m-learning and/or *Artefac*. Thirdly, endorsing self-approach goals is related to cooperation (Huang et al., 2021; Wolters, 2004). The collaboration dimension of *Artefac* may have allowed teachers with high self-approach goals to feel that this app would be easy to use because they usually collaborate with other teachers. Teachers' self-approach goals also positively predicted perceived enjoyment (H13). This result was expected because self-approach goals positively correlated with intrinsic interest in teaching (Mascret et al., 2017) and with student motivation (Çetin & Eren, 2022). It was therefore likely that teachers with high self-approach goals anticipated enjoying using this m-learning app.

But contrary to one of our hypotheses (H11), teachers' self-approach goals did not significantly predict perceived usefulness for teaching. We expected that continually striving to improve as a teacher would positively predict the perceived usefulness of *Artefac* and that teachers would want to incorporate it into their instructional practices. Indeed, other results from the present study showed that teachers found *Artefac* significantly useful for their teaching and that they significantly intended to use it. But the hypothetical prediction was not confirmed. However, this result is in line with the study of Mascret et al. (2017) which identified that teachers' self-approach goals were not correlated with teachers' instructional

practices (i.e., instructional dimensions used by teachers to implement a classroom structure, Lüftenegger et al., 2014). The pattern seems similar with perceived usefulness for teaching with *Artefac* but needs to be tested with other technologies than m-learning.

However, this last result does not call into question the interest of integrating teachers' self-approach goals as an external variable to the TAM applied to free, open-source, collaborative m-learning, since, on the one hand, these goals significantly predicted perceived ease of use and perceived enjoyment and, on the other hand, the model including teachers' self-approach goals accounted for 66.5% of the intention to use *Artefac*, which is a rather high percentage of explained variance.

#### **4.3. M-learning acceptance according to teachers' subject, status, and context**

No significant differences were found between science teachers and humanities and social science teachers on perceived usefulness for teaching, perceived ease of use, perceived enjoyment, and intention to use (H14, H15, H16, H17 validated). While some reviews (e.g., Al-Emran et al., 2018) have highlighted that several studies have been conducted with different school subjects, no studies have directly compared the scores of the TAM variables between science teachers and humanities and social science teachers. *Artefac* is an m-learning app that allows all teachers in different school subjects to produce, collect, and share academic resources specifically related to their school subject (videos, photos, recordings, quizzes, augmented reality). No differences have been found between science teachers and humanities and social science teachers because they may feel that the modularity of the collaborative m-learning app meets their needs as teachers and/or the needs of their students in their specific school subject (Teo et al., 2008).

Perceived usefulness for teaching, perceived ease of use, and perceived enjoyment were significantly higher for pre-service teachers than for in-service teachers (H18, H19, H20 validated). Although the concept of digital native is debated (Kirschner & De Bruyckere,

2017), pre-service teachers may be considered digital natives who usually use mobile technologies in their own life and for their own learning during their studies (Lai & Smith, 2018), and, consequently, they were more likely to use m-learning in their teaching than in-service teachers (Islamoglu et al., 2021). It is worth noting that our previous results showed that in-service teachers also have high scores of perceived usefulness for teaching, perceived ease of use, and perceived enjoyment, indicating that *Artefac* is nonetheless well accepted by in-service teachers. No significant differences were found between pre- and in-service teachers for intention to use it (H21 rejected), which was also high for the two subgroups. Although in-service teachers have lower scores on the other three TAM variables, they do not ultimately have a lower intention to use *Artefac*.

Finally, no significant differences were found between teachers in schools classified as difficult and teachers in schools not so classified on perceived usefulness for teaching, perceived ease of use, perceived enjoyment, and intention to use. These results are contrary to our hypotheses (H22, H23, H24, H25 rejected) and the results identified by Hoareau et al. (2021). The latter study was carried out with teachers in pre-schools only, teaching to students between three and six years old, while our study was conducted with teachers from across the whole range of schooling (three to eighteen years old), which could partly explain these differences. Moreover, Hoareau et al. (2021) recognized that teachers in schools classified as difficult faced more student heterogeneity and more schooling difficulties, and, therefore, “although the application was developed with pedagogical qualities, these remain insufficient to help students progress in Priority Education Network schools” (p.7). In a collaborative m-learning app such as *Artefac*, teachers program their own course modules and retrieve the resources that interest them to prepare their lessons, which makes the device much more adaptable, especially to the heterogeneity and difficulties of certain students considered difficult or failing. This modularity and flexibility of *Artefac* may explain why we did not find

significant differences of acceptance in the present study between teachers in schools classified as difficult and teachers in schools not so classified.

#### **4.4. Limitations and directions for future studies**

First, the use of convenience sampling to collect the data is a potential limitation regarding the generalizability of the results. Most of the pre-service teachers belong to the same university institute and most of the in-service teachers belong to the same geographical area of south-eastern France. Pre- and in-service teachers from different institutions and different geographical areas, but also from other countries, should be included in future studies.

Secondly, *Artefac* is only an illustration of an open-source, collaborative, free m-learning app, and other apps and/or devices could have been used to illustrate what a collaborative m-learning app can be, with another design or other functionalities.

Thirdly, the self-reported responses of the participants may have led some participants to be subject to social desirability (Phillips & Clancy, 1972). Although the questionnaires were fully anonymous, some teachers may not want to reveal that they are uncomfortable with m-learning technologies or with technologies in general.

Fourthly, the present study focused on *Artefac* acceptance before a first effective use of the devices on which the app is downloaded, to identify potential blockages among teachers in relation to this technology. Since initial technology acceptance may decrease or increase following an effective use (Venkatesh & Davis, 2000), comparing teachers' *Artefac* acceptance before and after use, and before and after a specific professional training in the use of this m-learning app, could provide relevant information about the dynamics of acceptance of *Artefac* and of open-source, collaborative, free m-learning apps in general.

Finally, the present study has shown that there does not seem to be any initial blockage among teachers before the first use of *Artefac*. The main characteristics of *Artefac*

which is collaborative (teachers share their pedagogical resources), free (it is freely available for teachers and students on Android and iOS platforms), and open-source (teachers may modify each teaching scenario) seem to be relevant to design and develop m-learning apps that meet the initial expectations of teachers whatever their school subject, their status, and the difficulty of their teaching context. However, since the use of *Artefac* with students will inevitably lead to changes in the way they teach (Dianati et al., 2021; Pynoo et al., 2011), it is essential to consider a study that will examine the appropriation of *Artefac* by teachers in a real teaching-learning situation, to extend key features that are required for pedagogical application.

## 5. Conclusion

A better understanding of teachers' technology acceptance is of major interest because including technologies in schools can, under certain conditions, allow teachers and students to take advantage of all their benefits to improve the effectiveness of teaching and student learning. The present study highlighted that an open-source, collaborative, free m-learning app named *Artefac* is well-accepted by teachers, before a first effective use, whatever their school subject, whether they are pre-service or in-service teachers, and regardless of the difficulty of their teaching context. It also showed that teachers' self-approach goals are a relevant external variable to include in the TAM to better explain acceptance. The implementation of this m-learning app among teachers to test its acceptance after a period of training and the study of its effective appropriation by teachers in a teaching-learning situation seem to be two promising avenues for further reflection.

## Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.



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**Table 1. Distribution of teachers according to their school subjects, status, contexts, and the educational level of the students they teach.**

	<b>Whole sample</b>	<b>Pre-service teachers</b>	<b>In-service teachers</b>
<b>Humanities and social science teachers</b>	54.7%	61.3%	46%
<b>Science teachers</b>	45.3%	38.7%	54%
<b>Schools classified as difficult</b>	29.6%	27%	32.8%
<b>Schools not classified as difficult</b>	70.4%	73%	67.2%
<b>Primary schools</b>	37.9%	42.2%	32.8%
<b>Secondary schools</b>	62.1%	57.8%	67.2%

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**Table 2. Descriptive statistics, skewness, kurtosis, internal consistency, composite reliability, average variance extracted, and correlations.**

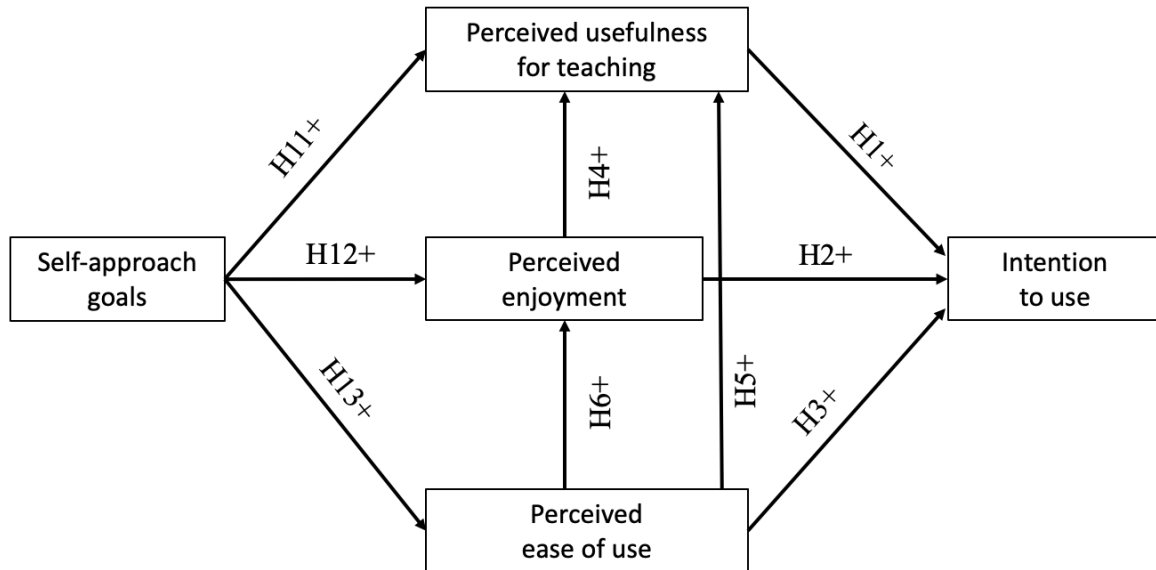
		Perceived usefulness for teaching	Perceived ease of use	Perceived enjoyment	Intention to use	Self-approach goals
Mean	Full sample	3.484	3.289	3.595	3.566	4.475
	Humanities and social science teachers	3.496	3.248	3.609	3.577	4.496
	Science teachers	3.470	3.339	3.579	3.553	4.449
	In-service teachers	3.349	3.200	3.454	3.500	4.473
	Pre-service teachers	3.595	3.362	3.712	3.620	4.477
	Schools classified as difficult	3.484	3.320	3.597	3.638	4.414
	Schools not classified as difficult	3.484	3.276	3.595	3.536	4.501
Standard deviation	Full sample	0.708	0.713	0.695	0.786	0.704
	Humanities and social science teachers	0.713	0.701	0.678	0.767	0.626
	Science teachers	0.703	0.725	0.716	0.810	0.789
	In-service teachers	0.717	0.731	0.714	0.833	0.762
	Pre-service teachers	0.681	0.690	0.657	0.742	0.655
	Schools classified as difficult	0.674	0.659	0.662	0.754	0.670
	Schools not classified as difficult	0.722	0.735	0.709	0.798	0.718
Skewness	Full sample	-0.433	-0.335	-0.721	-0.731	-1.740
	Humanities and social science teachers	-0.290	-0.203	-0.527	-0.557	-1.307
	Science teachers	-0.618	-0.498	-0.918	-0.909	-1.926
	In-service teachers	-0.179	-0.284	-0.758	-0.766	-1.949
	Pre-service teachers	-0.662	-0.359	-0.665	-0.644	-1.448
	Schools classified as difficult	-0.505	-0.360	-0.827	-0.638	-0.949
	Schools not classified as difficult	-0.409	-0.317	-0.687	-0.758	-2.035
Kurtosis	Full sample	1.094	0.348	1.551	1.016	4.270
	Humanities and social science teachers	0.606	0.395	1.061	0.470	1.985
	Science teachers	1.759	0.423	2.026	1.553	4.769
	In-service teachers	0.882	0.491	1.705	1.064	4.774
	Pre-service teachers	1.780	0.243	1.398	0.789	3.264
	Schools classified as difficult	1.428	0.694	2.011	0.670	0.346
	Schools not classified as difficult	1.001	0.234	1.424	1.121	5.739
McDonald omegas	Full sample	.850	.777	.848	.888	.916
	Humanities and social science teachers	.842	.799	.841	.934	.903
	Science teachers	.860	.753	.857	.890	.928
	In-service teachers	.859	.778	.878	.915	.910
	Pre-service teachers	.834	.771	.811	.860	.928
	Schools classified as difficult	.838	.721	.811	.872	.926
	Schools not classified as difficult	.856	.804	.863	.894	.914
Correlations	Composite reliability	.687	.665	.675	.785	.715
	Average Variance Extracted (AVE)	.424	.399	.409	.549	.457
	Perceived usefulness for teaching	-				
	Perceived ease of use	.341***	-			
	Perceived enjoyment	.713***	.482***	-		
	Intention to use	.736***	.424***	.751***	-	
	Self-approach goals	.163***	.117*	.181***	.172***	-

Note. \* $p < .05$ , \*\*\* $p < .001$

**Table 3. Summary of validated and rejected hypotheses**

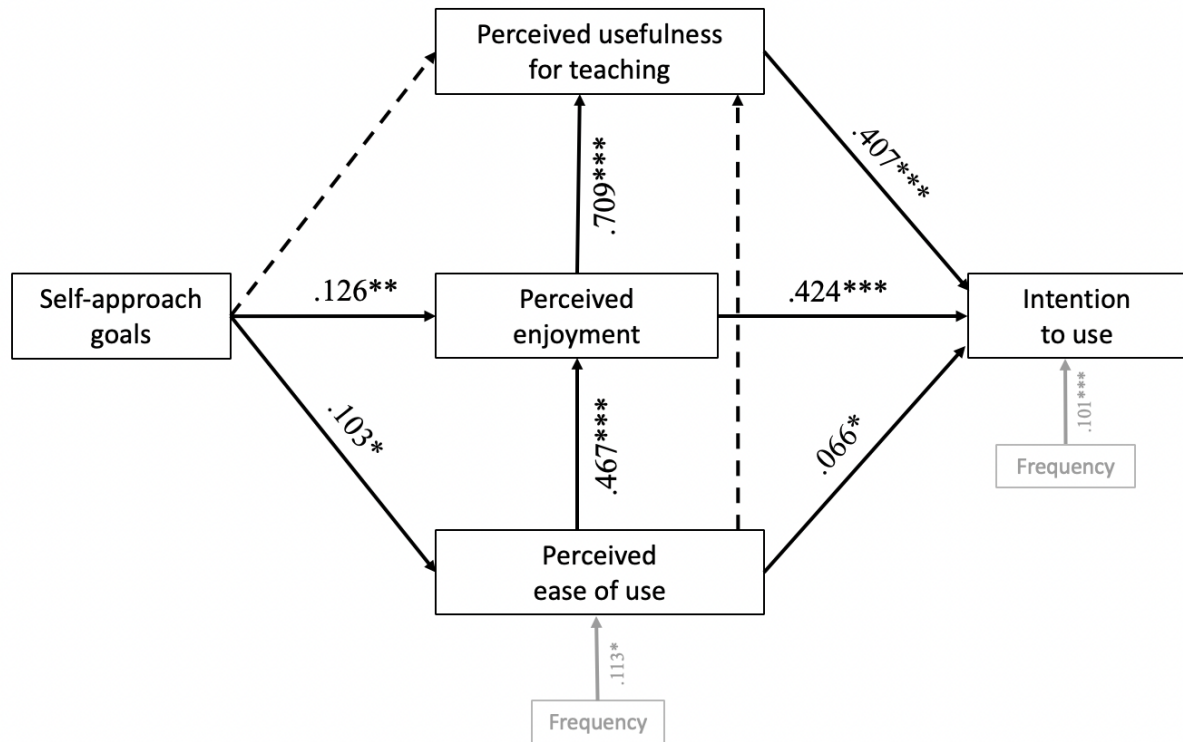
Type of hypotheses	N°	Hypotheses	Results
Intention to use	H1	Teachers' intention to use would be positively predicted by perceived usefulness for teaching.	Validated
	H2	Teachers' intention to use would be positively predicted by perceived enjoyment.	Validated
	H3	Teachers' intention to use would be positively predicted by perceived ease of use.	Validated
Ancillary hypotheses (TAM)	H4	Perceived usefulness for teaching would be positively predicted by perceived enjoyment.	Validated
	H5	Perceived usefulness for teaching would be positively predicted by perceived ease of use.	Rejected
	H6	Perceived enjoyment would be positively predicted by perceived ease of use.	Validated
Comparison with the mean of the scale	H7	Score of perceived usefulness for teaching would be higher than the mean of the scale	Validated
	H8	Score of perceived enjoyment would be higher than the mean of the scale	Validated
	H9	Score of perceived ease of use would be higher than the mean of the scale	Validated
	H10	Score of intention to use would be higher than the mean of the scale	Validated
Teachers' self-approach goals	H11	Teachers' self-approach goals would be a positive predictor of perceived usefulness for teaching.	Rejected
	H12	Teachers' self-approach goals would be a positive predictor of perceived enjoyment.	Validated
	H13	Teachers' self-approach goals would be a positive predictor of perceived ease of use.	Validated
Comparison between school subjects	H14	Score of perceived usefulness for teaching would not significantly differ between science teachers and humanities / social science teachers.	Validated
	H15	Score of perceived enjoyment would not significantly differ between science teachers and humanities / social science teachers.	Validated
	H16	Score of perceived ease of use would not significantly differ between science teachers and humanities / social science teachers.	Validated
	H17	Score of intention to use would not significantly differ between science teachers and humanities / social science teachers.	Validated
Comparison between status	H18	Score of perceived usefulness for teaching would be higher for pre-service teachers than for in-service teachers.	Validated
	H19	Score of perceived enjoyment would be higher for pre-service teachers than for in-service teachers.	Validated
	H20	Score of perceived ease of use would be higher for pre-service teachers than for in-service teachers.	Validated
	H21	Score of intention to use would be higher for pre-service teachers than for in-service teachers.	Validated
Comparison between contexts	H22	Score of perceived usefulness for teaching would be lower for teachers in schools institutionally classified as difficult than those of teachers in schools not classified as difficult.	Rejected
	H23	Score of perceived enjoyment would be lower for teachers in schools institutionally classified as difficult than those of teachers in schools not classified as difficult.	Rejected
	H24	Score of perceived ease of use would be lower for teachers in schools institutionally classified as difficult than those of teachers in schools not classified as difficult.	Rejected
	H25	Score of intention to use would be lower for teachers in schools institutionally classified as difficult than those of teachers in schools not classified as difficult.	Rejected

**Figure 1.** The hypothesized model.



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**Figure 2.** Validated model with standardized path coefficients. Dotted lines indicate non-significant paths. \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .

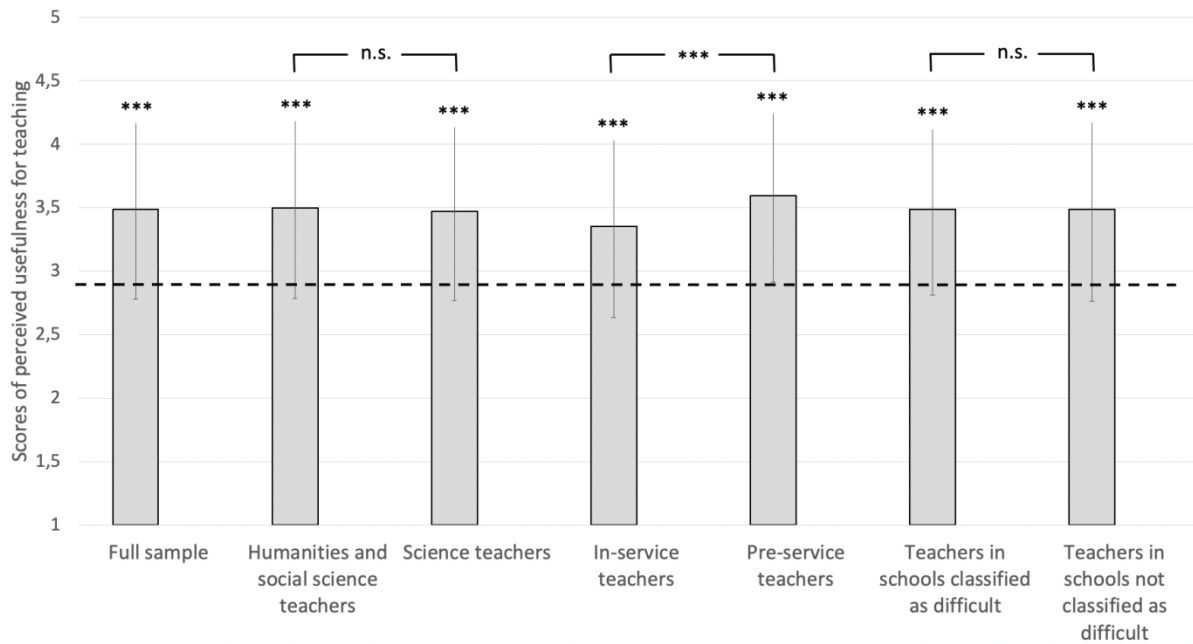


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**Figure 3.** Comparison with the mean of the scale for perceived usefulness for teaching is presented above each histogram bar. The dotted line represents the mean of the scale.

Comparisons between participants in different groups (subject, status, context) are presented in pairs. \*\*\* $p < .001$ , n.s. = non-significant.



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**Supplementary Material 1. Introductory text and questionnaires**

Thank you for agreeing to answer the various questionnaires that follow.

The digital tool *Artefac* is a free app allowing students to follow educational modules in mobile learning (on a tablet or smartphone). It allows teachers (via a computer) to create or use these modules in a flexible way and can include text, audio, augmented reality, video, animations, interactive questions, etc.

Free and community based, *Artefac* makes it possible to put online scenarios developed to be reused as they are or to be modified, thus creating in a participative way a multitude of modules to help students to learn. The *Artefac* database is therefore open to the addition of new resources (videos, 3D images, etc.) offering teachers of all school subjects and all levels the opportunity to integrate it into their teaching in any way they wish. *Artefac* can be used directly in the classroom by the teacher and students, but it can also be used by students outside the school.

**Questionnaire #1: Acceptance**

*Artefac* would be useful in improving my teaching effectiveness.

I think using *Artefac* would be easy.

Using *Artefac* in my teaching would be fun.

If I had easy access to *Artefac*, I would probably use it in my teaching.

*Artefac* would improve the quality of my teaching.

It would be easy for me to learn to use *Artefac*.

Using *Artefac* in my teaching would be fun.

I intend to use *Artefac* in my teaching when this application is available.

*Artefac* would be useful for my teaching.

I think that using *Artefac* would be easy to understand.

Using *Artefac* in my teaching would be engaging.

If I had access to *Artefac*, I would want to use it in my teaching.

**Questionnaire #2: Self-approach goals**

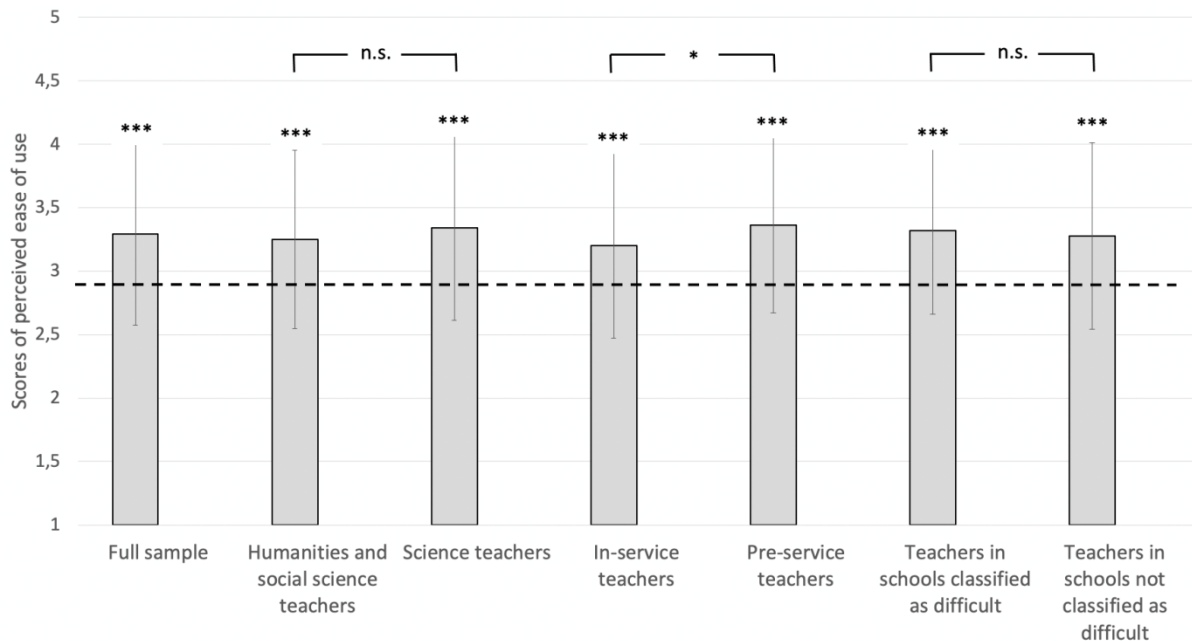
When I teach, I try to teach more effectively than before.

When I teach, I seek to be better than before in my teaching.

When I teach, I seek to teach better than before.

**Supplementary Material 2.** Comparison with the mean of the scale for perceived ease of use is presented above each histogram bar. The dotted line represents the mean of the scale.

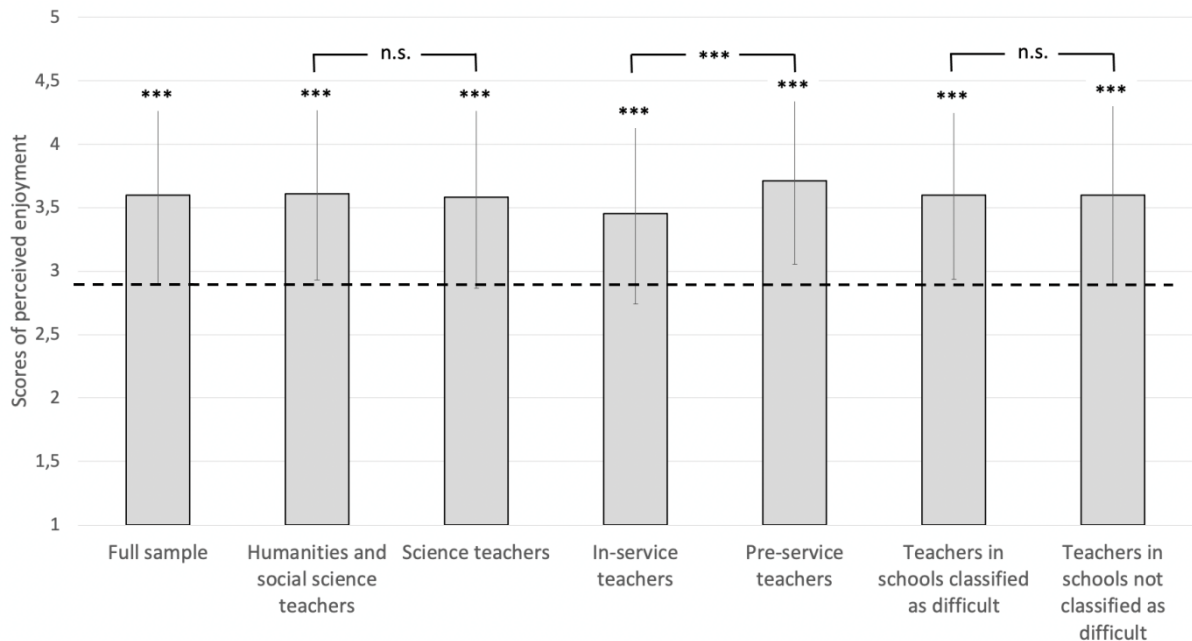
Comparisons between participants in different groups (subject, status, context) are presented in pairs.  $*p < .05$ ,  $***p < .001$ , n.s. = non-significant.



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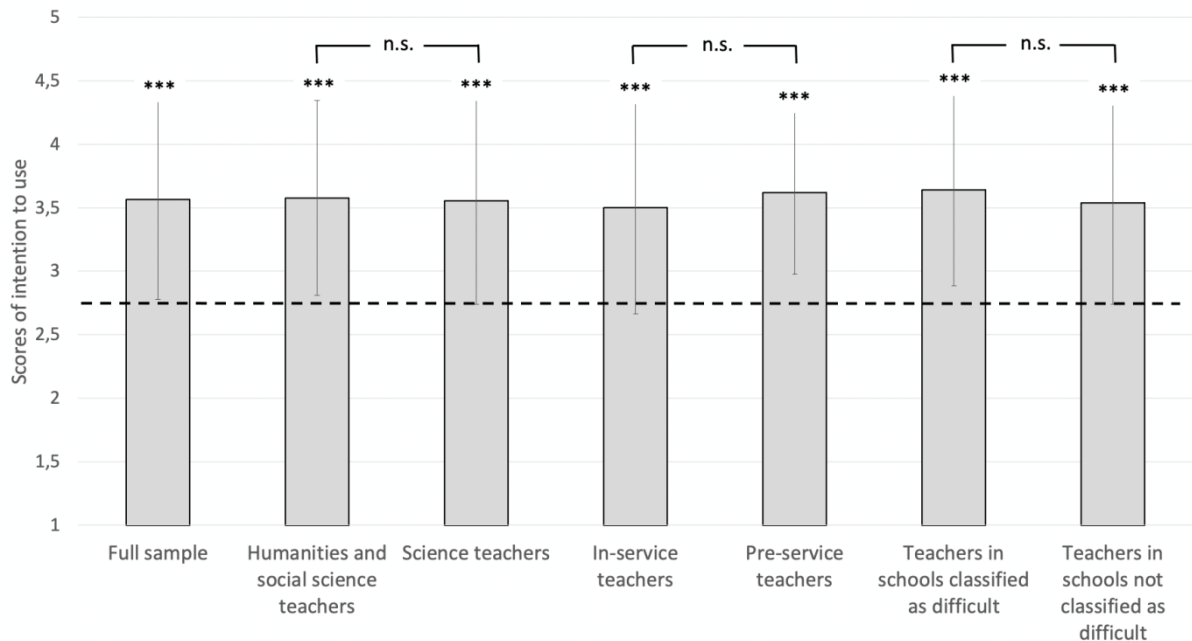
**Supplementary Material 3.** Comparison with the mean of the scale for perceived enjoyment is presented above each histogram bar. The dotted line represents the mean of the scale.

Comparisons between participants in different groups (subject, status, context) are presented in pairs. \*\*\* $p < .001$ , n.s. = non-significant.



Accepted

**Supplementary Material 4.** Comparison with the mean of the scale for intention to use *Artefac* is presented above each histogram bar. The dotted line represents the mean of the scale. Comparison between participants in different groups (subject, status, context) are presented in pairs. \*\*\* $p < .001$ , n.s. = non-significant.



Accepted