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pedocs

DIPF | Leibniz-Institut für Bildungsforschung und Bildungsinformation Informationszentrum (IZ) Bildung E-Mail: pedocs@dipf.de Internet: www.pedocs.de

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ORIGINAL ARTICLE

Fostering children's acceptance of educational apps: The importance of designing enjoyable learning activities

Chimezie O. Amaefule¹ I Jasmin Breitwieser¹ Daniel Biedermann¹ L Garvin Brod^{1,3}

Lea Nobbe¹ | Hendrik Drachsler^{1,2}

¹DIPF | Leibniz Institute for Research and Information in Education, Frankfurt am Main, Germany

²Computer Science Faculty, Goethe University Frankfurt, Frankfurt am Main, Germany

³Institute of Psychology, Goethe University Frankfurt, Frankfurt am Main, Germany

Correspondence

Chimezie O. Amaefule, Education and Human Development, DIPF | Leibniz Institute for Research and Information in Education, Rostocker Strasse 6, 60323 Frankfurt am Main, Germany. Email: amaefule@dipf.de

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Abstract

Educational applications (apps) offer opportunities for designing learning activities children enjoy and benefit from. We redesigned a typical mobile learning activity to make it more enjoyable and useful for children. Relying on the technology acceptance model, we investigated whether and how implementing this activity in an app can increase children's intention to use. During the 27-day study, children (N = 103, 9–14 years) used the app to memorize one-sentence learning plans each day. Children used three different app-based learning activities throughout the study. In two standard activities, children reread or reassembled the words of the plan. In the redesigned activity, children represented the meaning of the plan with emojis. Children repeatedly reported on their attitude towards each activity. Subsequently, children reported perceived enjoyment and intention to use the app. Results showed children found the emoji activity most enjoyable, and enjoyment of the emoji activity contributed uniquely towards intention to use. Additionally, children's enjoyment of the app mediated their intention to use the app in the future. Overall, the study suggests that children's enjoyment of an app is crucial in predicting their subsequent intention to use, and it provides a concrete example of how emojis can be used to boost enjoyment.

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KEYWORDS

attitude, behavioural intention to use, educational technology, emoji, mobile learning, perceived enjoyment, technology acceptance

Practitioner notes

What is already known about this topic

- Educational applications provide children with unrestricted access to mobile learning resources.
- Positive attitudes towards educational applications predict behavioural intention to use these applications, at least in young adults.
- There is a need for more research examining the relevance of enjoyable learning activities in fostering children's sustained usage of an educational application.

What this paper adds

- Positive attitude towards the use of emojis during learning activities uniquely contributed to children's behavioural intention to use the application.
- Perceived enjoyment predicted behavioural intention to use the application.
- Perceived enjoyment mediated the effect of attitude towards using learning activities on the behavioural intention to use the mobile educational application.

Implications for practice and/or policy

- These findings highlight the importance of enjoyment for children's' acceptance of educational applications.
- Enjoyable learning activities are necessary to ensure sustained usage of educational applications.
- The paper provides a concrete example of how emojis can be used to boost enjoyment of a typical mobile learning activity.

INTRODUCTION

Mobile technologies allow students to access and interact with learning resources anywhere and anytime. Educational applications (apps) installed on hand-held mobile devices such as smartphones and tablets are increasingly being used among school children. Even prior to the COVID-19 pandemic and the associated increase in adoption of remote teaching (Drachsler et al., 2021), Tahir and Arif (2014) noted that a wide variety of educational apps available in the market target young children, predominantly to improve their learning experience (Camilleri & Camilleri, 2019). Educational apps can be useful tools for supporting children's learning, as they can provide personalized, engaging and convenient learning experiences. Many studies have shown that educational apps can have a positive impact on children's learning outcomes, including their academic performance, motivation and engagement (Herodotou, 2018; Kay, 2020; Kim et al., 2021).

The proliferation of educational apps does not necessarily translate to children accepting and using them in the long-term, however. Apart from system quality factors such as relatively small screens, school children may hold different attitudes towards the use of educational apps for various reasons. One of such reason lies in the nature of the educational app content. Educational apps that include game-like elements have been utilized more,

as these technologies provide an immersive, voluntary and enjoyable experience to their users (Bourgonjon et al., 2010; Hwang & Wu, 2012), thereby enhancing students' motivation to learn (Burguillo, 2010; Dickey, 2011). Motivation is an important factor in learning for children. When children are intrinsically motivated, they are driven to engage in an activity for its own sake because they perceive it as personally meaningful and enjoyable (Carlton & Winsler, 1998; Schunk et al., 2008). Intrinsic motivation is also linked to better learning outcomes and academic achievement (Froiland & Worrell, 2016; Gottfried, 1985). In order to foster motivation and engagement in children, it is important to find ways to make learning fun and relevant to their interests. Educational apps can be a useful tool for achieving this, as they can provide personalized learning experiences that are tailored to a child's individual needs and interests (Campbell & Jane, 2012). This can help to keep them engaged and motivated, as they feel that the content is relevant and meaningful to them.

However, there is still limited research focusing on children's acceptance of educational apps in particular. Thus, investigating how learning activities that elicit different levels of enjoyment and engagement affect school children's acceptance of educational apps and their behavioural intentions to use it is critical for designing more useful, usable and desirable educational technology.

Technology acceptance

The effective implementation of any information technology or information system depends on user acceptance (Davis, 1989). Technology acceptance refers to the willingness of individuals or organizations to adopt and use new technology, and is influenced by factors such as the perceived usefulness and ease of use of the technology, as well as social and cultural barriers to adoption (Davis et al., 1989; Venkatesh et al., 2003). A number of theoretical frameworks and models have been considered in exploring students' engagement with educational technologies in different contexts, including the Technology Acceptance Model (Davis, 1989; Davis et al., 1989), the Theory of Planned Behaviour (Ajzen, 1991), the Self-Determination Theory (Chen & Jang, 2010; Lee et al., 2005) and the Unified Theory of Acceptance and Use of Technology (Chao, 2019; Venkatesh et al., 2003).

The Technology Acceptance Model is one of the most widely applied and cited frameworks in the field of information technology (Chao, 2019; Sung et al., 2015). It posits that individuals' behavioural intention to use technology is determined by their attitude, which is, in turn, influenced by the usefulness and the ease of use of the information systems (Davis et al., 1989). Perceived usefulness and perceived ease of use determine the individuals' attitude towards computer usage behaviours (Davis et al., 1989). Scholars extending the Technology Acceptance Model, such as those developing the Unified Theory of Acceptance and Use of Technology, have argued for the inclusion of additional external variables such as self-efficacy, trust, habits, satisfaction, perceived enjoyment and perceived risk. They argue these factors enhance a given model's ability to predict the acceptance of information technology (Chao, 2019; Venkatesh et al., 2003). Of the additional external variables suggested, perceived enjoyment has particularly been shown to influence the behavioural intention to use technology, especially in the case of mobile learning among children (Camilleri & Camilleri, 2019). In line with the finding of Camilleri and Camilleri (2019), the current study aimed at examining how learning activities that elicit different levels of enjoyment and engagement affect school children's acceptance of an educational app and their intentions to use it. We, therefore, explored the original concepts proposed in the Technology Acceptance Model (ie, perceived usefulness, perceived ease of use, attitude and behavioural intention) with the addition of perceived enjoyment. Perceived enjoyment has previously been shown to influence attitude towards educational technology usage (Tsai et al., 2018) and the behavioural intention to use mobile learning and mobile services (Chao, 2019; Lee et al., 2005; Wang & Li, 2012) among adults.

The behavioural intention to use technological innovations is an important factor that determines whether users will actually utilize the technologies (Venkatesh et al., 2003). Most theories in the technology acceptance field (eg, Theory of Reasoned Action, Theory of Planned Behaviour and Technology Acceptance Model with its many extensions) have used user intention as the most direct antecedent of actual usage. Furthermore, previous studies have explored the relationship between behavioural intention and actual usage of technology in different contexts (Chang et al., 2017; Park et al., 2012; Venkatesh et al., 2003, 2012), and have confirmed that behavioural intention has a high correlation with actual usage (see Almaiah & Alismaiel, 2019). These findings suggest that factors predicting behavioural intention to use educational apps among children could be relied upon as indicators of their technology acceptance. The following subsections provide an overview of the predictors of behavioural intention proposed in the Technology Acceptance Model, indicating what aspects were investigated in the current study and the novel concept included, is presented in Figure 1.

Perceived ease of use

Perceived ease of use is the degree to which a person believes that using a particular system would be free of effort (Davis, 1989). In other words, this factor describes the extent to which an individual thinks that a particular technology is user friendly. In the context of educational technology, Joo et al. (2014) pointed out that the perceived ease of use is a student's belief that a device can be used without particular difficulty. Effort expectancy is a concept in the Unified Theory of Acceptance and Use of Technology which shares conceptual similarity with perceived ease of use (Venkatesh et al., 2012), and has equally been shown to influence mobile learning acceptance (Sung et al., 2015). However, individuals may find mobile learning difficult to understand and use, and may likely reject the technology if they think that the technology is complex, tedious and/or time-consuming. For this reason, perceived ease of use constant, 1989;



FIGURE 1 Depiction of the technology acceptance model indicating what aspects were investigated in the current study and the novel concept included. Dashed arrows and boxes represent concepts and relationships not tested in the current study. Perceived enjoyment is included in a grey box to emphasize its novelty and mediational role.

Davis et al., 1989). Indeed, if students find it easy to use the technology, they will likely accept it (Ali & Arshad, 2016). In sum, this suggests that perceived ease of use plays a key role for technology acceptance.

Perceived usefulness

Perceived usefulness refers to the degree to which a person believes that using a particular system would enhance their performance (Davis, 1989). This factor captures the degree to which a person believes that the technology will contribute towards performing a certain task in an efficient and productive manner. In the context of mobile learning, perceived usefulness indicates the degree to which a student believes that a mobile phone will help them accomplish educational goals (Huang et al., 2007; Joo et al., 2014). Perceived usefulness has a direct effect on the behavioural intention to use, and thereby indirectly impacts actual usage of the technology (Davis et al., 1989). As in the case of perceived ease of use and effort expectancy, perceived usefulness conceptually overlaps with performance expectancy in the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003), and has been shown to be associated with behavioural intention to use (Kaliisa et al., 2019; Sung et al., 2015). Students will adopt mobile learning technology if they believe it will improve their performance (Ali & Arshad, 2016). Taken together, perceived usefulness has been shown to be positively related to behavioural intention to use.

Attitude towards using

Attitude refers to an individual's disposition to respond favourably or unfavourably to an object, person, institution, event, or any other discriminable aspects of the individual's world (Ajzen, 1989). The attitude of a person is expressed in the level to which one has a positive or negative opinion about the performance of a particular behaviour (Raza et al., 2018). Some studies suggest that the attitude of a learner towards mobile learning affects the learner's behaviour with regard to using the system (Gan et al., 2017; Sharma et al., 2017).

According to the Technology Acceptance Model, people's attitude towards a new technology is determined by (a) the belief that using the technology is effortless (ie, perceived ease of use) and (b) the belief that using the technology will enhance performance (ie, perceived usefulness). This is then expressed in a person's affective reaction to the technology (eg, enjoyment, see Venkatesh et al., 2003). Extending the Theory of Reasoned Action, the Technology Acceptance Model assumes that attitude is the main predictor of the behavioural intention to use a technology, which in turn predicts actual use. Therefore, school children's attitudes towards using learning activities presented in an educational app are a considerable factor in evaluating educational technology acceptance among children.

Perceived enjoyment

In addition to extrinsic motivations (ie, perceived ease of use, perceived usefulness), intrinsic motivations could also have an effect on users' engagement with educational technology (Lee et al., 2005). Intrinsic motivation involves the performance of an activity for no apparent reinforcement other than the process of performing the activity (Chen & Jang, 2010; Ryan & Deci, 2000). Perceived enjoyment is a fundamental intrinsic motivation that specifies the extent to which fun can be derived from using information technology or an information

system (Chao, 2019). It has been argued to be a significant determinant of the behavioural intention to use mobile learning and mobile services (Lee et al., 2005; Wang & Li, 2012).

The effect of perceived enjoyment on system use has been confirmed in several studies. For instance, perceived enjoyment was significantly related to the attitude towards, and indirectly, to the behavioural intention of using a blended e-learning system (Tsai et al., 2018). In the case of mobile learning, Chao (2019) additionally provides evidence linking perceived enjoyment and behavioural intention to use mobile learning. Furthermore, a low behavioural intention to use mobile learning. Furthermore, a low behavioural intention to use mobile learning. Furthermore, a low behavioural intention to use mobile learning systems by university students has been attributed to student's failure to appreciate and feel the enjoyment in the usage of mobile learning systems despite its benefits (Huang, 2014). Considering that perceived enjoyment has been shown to be a positive and significant antecedent for third graders' behavioural intention to engage with an educational game (Camilleri & Camilleri, 2019), it becomes evident that educational apps need to be enjoyable in order to enhance children's acceptance of these apps. Despite the plausible importance of perceived enjoyment in children's adoption of mobile learning, there are sparse studies (Camilleri & Camilleri, 2019; Espinosa-Curiel et al., 2020) investigating this relationship.

How to foster children's enjoyment during memorization activities

As part of the learning process, children often have to memorize information. In the context of mobile learning, there are a number of educational apps that aim to improve children's learning by making memorization easier, more engaging and fun. An example of such an app is Duolingo (https://www.duolingo.com), a language learning app. It promotes user engagement by providing tasks in which users must unscramble word puzzles. Other educational apps, often referred to as 'planner apps', focus on improving student's learning habits by boosting their motivation to learn, helping them track their learning progress and maintain a more regular study pattern. An example of such apps is the Ace your Self-Study app (https:// aceyourselfstudy.nl/) which targets planning as a self-regulation strategy to help learners maintain a regular study schedule by sending them regular prompts based on pre-selected criteria (eq, study plans; Baars et al., 2022). Progress tracking allows learners to see the study progress that they have made over time. This can be helpful in encouraging motivation to learn in order to achieve the goals set (Denzine & Brown, 2015). While these apps employ different approaches towards improving children's learning, to the best of our knowledge, none of these studies have systematically evaluated if and how the different kinds of memorization and planning activities within these apps contribute to children's enjoyment of the apps.

Gamification is a major approach to making mobile learning enjoyable for children. This approach entails fun elements or activities being employed to motivate and engage users (Girard et al., 2013). Most educational apps do not involve full-fledged games, however, but adopt certain game design elements (Deterding et al., 2011; Dichev et al., 2015). Two particular game design elements which are of interest to the current study are *challenges* and *autonomy* (Dichev et al., 2015). In relation to challenges, the Duolingo app (https://www. duolingo.com) elicits memorization tasks in which users must unscramble word puzzles, which can be seen as a desirable difficulty (Bjork & Bjork, 2011) that promotes active engagement with the learning task. The Ace your Self-Study app also includes challenges such as planning sessions and uses learning strategies intended to stimulate students to explore different types of study strategies (Baars et al., 2022). In both cases, users have to stick to a predefined pattern of fulfilling the task, thus limiting their autonomy. While challenging activities may support user engagement, autonomy in fulfilling these tasks may contribute more to users' satisfaction and enjoyment of the particular activity. Dichev et al. (2015) provide

evidence in support of this argument, reporting that students who perceive themselves to be acting with a sense of autonomy, competence and relatedness during the learning activity experience high-quality motivation.

According to the Self-Determination Theory (Ryan & Deci, 2000), an individual's motivation is influenced by three basic psychological needs: autonomy, competence and relatedness. When these needs are met, individuals experience greater psychological well-being and improved performance (Ryan & Deci, 2017). Competence and autonomy are two key elements of self-determination theory that may promote enjoyment for apps. Competence describes the experience of mastery and effectiveness in an individual's activity. Competence is brought about by the provision of optimal challenges and opportunities. That is, situations involving specific goals which are challenging enough but not overwhelming. Autonomy describes the feeling one has choice and is willingly endorsing one's behaviour. Autonomy is brought about by providing choice in how to behave. When individuals have sufficient autonomy, they are more likely to view their activities as self-directed, leading to greater intrinsic motivation and engagement (Ryan & Deci, 2000). In sum, by providing an appropriate level of challenge and autonomy, educational apps have the potential to cater to basic psychological needs and thereby to increase users' enjoyment and engagement.

Including emojis could be a promising approach for making simple learning tasks more enjoyable for children and to give them a sense of autonomy and challenge. Emojis as a tool of communication are now part of our everyday culture. While emojis are typically used in chat communication, their potential in the communication of internal states has been the subject of research (eg, Schouteten et al., 2018; Vaughn et al., 2020). The advantage for using emojis with younger children is apparent; even with a limited vocabulary, they can use emojis to communicate complex content with considerable subtlety (Padilla López & Cap, 2017), while requiring considerably fewer words to be typed. The use of emojis also leaves room for creative freedom and individual expression. Emojis have been shown to promote active participation of children both during mobile learning (Suhaimi et al., 2018) and participatory research with children (Mackenzie et al., 2018). In a WhatsApp-based learning platform, elementary school children reported feeling more excitement and better engaged in the learning activity, owing to the availability and use of emojis (Suhaimi et al., 2018). Emojis have also been argued to support online learning and improve learning efficiency (Dunlap et al., 2016). In summary, emojis are more likely to elicit the combined elements of autonomy and challenge, considering that their usage entails interactivity (ie, user is aptly engaged with the dynamic task of choosing a representative emoji) and freedom of choice (ie, user is autonomous in choosing a representative emoji).

In a previous study (Biedermann et al., 2023), an investigation of children's attitude towards memorization using either emojis, puzzles, or reading activities, yielded outcomes in favour of the emoji activity. The emoji activity was designed to provide an effective and more enjoyable memorization activity for children, compared to the more popular methods of scrambling and reading. In summary, children reported a more positive attitude (composite score of perceived enjoyment, perceived ease of use and perceived usefulness) towards the emoji activity, and were also 1.47 times more likely to correctly recall plan sentences memorized with the emoji activity than the puzzle activity (Biedermann et al., 2023). Considering this outcome, our objective for the current study was to further elucidate the relevance of enjoyable learning activities in fostering children's sustained usage of an educational app. To this end, we used the same dataset as Biedermann et al. (2023) (described below) but used additional measures of perceived enjoyment and behavioural intention not considered in that manuscript.

The present study

In a longitudinal experimental design, we compared three different learning activities within one educational app with a view to determining their contribution to children's perceived enjoyment of the app and their behavioural intention to continue to use the app. Learning activities took place on children's smartphones in their daily lives, and enjoyment was assessed through experience sampling, also on their smartphones. Children had to learn simple sentences that were phrased as plans with three different learning activities: (1) The text reading activity in which the children should read the content, and remember it. The activity does not use the possibilities for interactivity that are offered in learning on the smartphone. (2) The puzzle activity in which the individual words initially appear on the screen in random order, and must be selected in the correct order. For this activity, the idea was that it would be more enjoyable for children than the text reading activity because it offers interactivity without having the children type in the whole sentence. However, the words have to be selected in a predefined manner, thereby limiting autonomy. (3) The emoji activity in which children had to represent the meaning of the sentence with emojis. The idea behind this activity was that it offers interactivity without having the children type in the whole sentence, and additionally elicits more enjoyment for the children than the puzzle and text reading activities, considering that the children enjoy more autonomy in choosing what elements they perceive as representative of the plan sentence.

The study was performed in the context of the PROMPT app, which aims to promote children's self-regulated learning (see Biedermann et al., 2023; Breitwieser et al., 2022). Therefore, the learning activities aimed at internalizing plans, because planning is an important step in self-regulated learning (as described in more detail in Biedermann et al., 2023). However, for the purpose of this paper, it can be regarded as a standard memorization activity, and our results should therefore generalize to similar forms of memorization (eg, learning phrases in a foreign language).

We measured *attitude* (derived from perceived usefulness and perceived ease of use) towards usage of the distinct activities (ie, emoji, puzzle, reading) over the course of 4 weeks. We also measured *perceived enjoyment* of the app as a whole at the end of the study period. Obtaining repeated attitude measures in this way provides for both a more reliable and externally valid measure of attitude compared to typical one-short experimental designs or questionnaire studies. The rationale for including perceived enjoyment as an internal factor in our model, was to investigate if perceived enjoyment, in addition to predicting *behavioural intention* (Camilleri & Camilleri, 2019; Chao, 2019), also mediates the effect of attitude on behavioural intention. Moreover, we assumed that learning activities which children have a more positive affect towards would be more predictive of their perceived enjoyment of the educational app. Note that this is different from Biedermann et al. (2023) because attitude is defined differently (ie, composite score of perceived ease of use and perceived usefulness) in the current study following the proposition of the Technology Acceptance Model (Davis et al., 1989).

We expected that children would have a more positive attitude towards the emoji activity than the puzzle or reading activity (ie, Attitude Emoji > Attitude Puzzle > Attitude Reading). Therefore, guided by the Technology Acceptance Model, the current study examined first, if children experience a more positive attitude towards the emoji activity than the puzzle or reading activity, second, if attitudes towards performing the distinct activities and perceived enjoyment of the educational app have effects on children's behavioural intention to use the app and third, to what extent perceived enjoyment of the app influences the effect of attitude

towards using the distinct activities on behavioural intention to use the app among children. Thus, this study explores the following hypotheses:

H1 Children show a more positive attitude towards the emoji activity than towards the puzzle and reading activity.

H2 Children's attitude towards performing the emoji activity uniquely predicts their behavioural intention to use the educational app.

H3 The effect of children's attitude towards the emoji activity on their behavioural intention to use the app is mediated by their perceived enjoyment of the app.

METHODS

Participants

The sample included German-speaking children in grades 4 to 7 (late elementary and early high school level in the German school system; age range 9-14 years). Children were recruited in Spring 2021 via the social media platforms of our institute, a newsletter that was sent to children using a vocabulary learning app, email distributors of parents' councils across Germany, and flyers distributed in the area of Mainz, Germany. Children and their guardians were forwarded to an online consent form to register for participation; 183 children were registered, of whom 114 participated in the study and completed at least one assessment. Upon inspection of the data, a total of 11 children were excluded due to incomplete tasks or implausible entries. Thus, the final sample for the analyses presented here consists of 103 children (58% female; M_{age} = 11.78 years, SD_{age} = 1.03 years; $M_{grade \ level}$ = 5, SD_{grade level} = 0.96). Following the completion of the consent form, socio-demographic information was obtained from children's legal guardians via an online questionnaire. The form requested the children's gender, birth date, school type, grade level, federal state and native language. A table summarizing the characteristics of the final sample can be found in the Supplementary Material. We conducted usability tests with four children in the same age range as our target audience to rule out usability and comprehensibility difficulties with the app. We requested the children to complete all study tasks within the app loaded on their personal mobile devices during these usability testing. We utilized a think-aloud protocol (Lewis, 1982) and asked the children to say out loud anything they thought about the app and whenever they had any questions. With the exception of one child who was assessed in person, all sessions were carried out remotely via webcam that was pointed at their smartphone screens. Further details on participants' socio-demographic information and the usability of the app can be found in Biedermann et al. (2023).

As compensation for their participation, children received a gift card for an online shop of their guardian's choice. The value of the gift card varied between 50 cents and 12 Euros depending on a child's participation rate. Ethics approval was obtained from the ethics committee of DIPF | Leibniz-Institut für Bildungsforschung und Bildungsinformation, approval number DIPF_EK_2021_33.

Materials and measures

Learning activities

The study was conducted in the [blinded] app that we developed as a research platform. Within the app, children had to memorize sentences that all had a similar sentence length



AMAEFULE ET AL.

and complexity. The sentences represented pre-created learning plans with an if-then format (Gollwitzer, 1999). If-then plans have been shown to support the attainment of learning goals (Gollwitzer et al., 2011). Note that, because of the current paper's focus on condition differences in attitude, as well as, behavioural intention for continued usage, both the nature of the sentences (ie, them being plans) and learning success are largely irrelevant. These aspects form part of a different paper (Biedermann et al., 2023). Plans were presented within the app with one of three internalization activities: emoji, puzzle, or reading (see Figure 2).

In the A_emoji activity, children were asked to create a representation of their plan using emojis. The plan was displayed at the top of the screen, and the emojis had to be entered into separate input fields for the 'if'-part of the plan and for the 'then'-part of the plan. To prevent the influence of idiosyncrasies of smartphone on-screen keyboards, we created a custom emoji picker that included the emojis available in popular messaging apps. Children who are familiar with chat apps should be able to find the emojis they use in everyday life. The children could move on to the next screen after an emoji was entered into both the 'if' and the 'then' input fields. In contrast to the other two conditions, the emoji activity involved interaction, autonomy in selecting emojis and continuous presentation of the plan.

In the A_puzzle activity, the plan was displayed for 8 seconds before fading out. After the plan disappeared, it was segmented into individual words that were displayed in random order on the screen. By tapping on one of these words, it was added to the finished sentence. The children could only move on to the next screen when they had puzzled the complete sentence together correctly. Compared to the other two conditions, the puzzle activity involved interactivity in the absence of autonomy, and the plan was visible for a shorter duration than in the reading activity.

In the A_reading activity, the plan was displayed together with instructions to read it through at least three times. At the earliest, the children could move on to the next screen after 15 seconds had elapsed. The time was presented in the form of a loading bar. The reading activity did not involve any interactive elements, and the plan was visible for a little bit longer than it was during the puzzle activity.



FIGURE 2 Screenshots of the emoji (a), puzzle (b), and reading (c) learning activities.

RIGHTSLINK()

Attitude, perceived enjoyment and behavioural intention to use

Children's attitude towards the learning activities was assessed with two items each time children had used an activity three consecutive times. That is, children who completed the study reported their attitude nine times (three times per activity) throughout the study. Different to a previous study (Biedermann et al., 2023), here we only considered the two items which are proposed in the Technology Acceptance Model as contributors to attitude (Davis, 1989). Hence, the items captured children's perceived usefulness ('Were you able to remember the plans better with this activity'?), and perceived ease of use ('How exhausting was it to remember the plans with this activity'?). Children answered each item on a 5-point Likert scale (1 = 'not at all', 5 = 'very'). We re-coded the item on perceived ease of use. The mean scores of the two items correlated moderately (0.47). We calculated the mean of the two items to obtain a score for children's attitude towards the learning activities.

Furthermore, at the end of the study, we asked children about their perceived enjoyment of the app ('How much did you enjoy using the app'?) and their behavioural intention to continue using the app ('Would you continue to use the app'?). Children equally answered each item on a 5-point Likert scale (1 = 'not at all', 5 = 'very'). The questionnaires containing the items were designed based on the underlying constructs of the Technology Acceptance Model (Davis, 1989). Specifically, they were adapted from questionnaires employed in previous studies (see Alfadda & Mahdi, 2021; Yang & Wang, 2019). In the current study, we limited the questionnaires to single-item measures, considering that it is common practice to adjust Information Technology related items to fit the digital systems/features and population under investigation (Camilleri & Camilleri, 2019; Espinosa-Curiel et al., 2020). Also, the use of single-item measures is common in experience sampling studies to reduce participant burden and decrease dropout (Gogol et al., 2014). All questionnaires were administered via the app.

Study design and procedure

Children were presented with one of three activities (emoji, puzzle or reading) to learn one plan per day (Figure 3). The same activity was used for three consecutive days, after which a different activity was performed for 3 days and so on (see Biedermann et al., 2023). Thus, children who completed the study learned 27 plans over the course of the study (within-subject design). We chose to present each activity on three consecutive days so that the children had time to familiarize themselves with the activity and form an opinion about it before reporting their attitude towards using the activity (see section 'Attitude, perceived enjoyment and behavioural intention to use').

We counterbalanced the order of the activities to control for sequence effects (ie, one-third of the children started with the emoji activity, one-third with the puzzle activity and one-third with the reading activity). In total, there were six groups with different orders of activities.



FIGURE 3 Overview of the study design. The order of conditions was counterbalanced.

AMAEFULE ET AL.

Children were assigned to groups in the order of their registration (ie, the first child was assigned to group 1, the second to group 2 and so on).

After installing the app, the children were asked to complete several guestionnaires (including socio-demographics, learning goals, motivation, multimedia usage, self-regulation) in an initial session, and received detailed instructions about the study and the three activities. In the initial session, children also provided responses to questions concerning their Information Technology (IT) literacy, that is, their knowledge about and use of information technology. These questions included their IT literacy age (ie, at what age they started to use IT), IT literacy duration (ie, how long they use IT on a typical day) and IT literacy learning (ie, if they learn better with digital learning mediums, eg, apps or with analogue learning mediums, eg, books). The IT literacy age and duration questions were adapted from The ICT Familiarity Questionnaire (OECD, 2017), while the IT literacy learning question was constructed by the authors. The IT literacy learning question was answered on a 5-point Likert scale (1 = 'not at all', 5 = 'very'), while the IT literacy duration question was answered on a 4-point scale (1 = 'not at all', 4 = 'above 4 hours'). For the IT literacy age question, children responded on a 3-point scale (1 = '3 years or younger', 3 = '7 to 9 years'). The actual study began on the day after the initial session. From the first day on, the app sent a reminder notification every morning at 6:30 a.m. to remind the children of the activity which had to be completed before 6 p.m. The time point for sending reminder notifications was chosen to have at least a 6-hour break between the learning activity and a subsequent recall task without a night of sleep between both tasks, as we expected sleep to significantly affect memory performance (Scullin & McDaniel, 2010). Therefore, the reminder notification to perform the recall task appeared 6 hours after the completion of the learning activity.

Children were given a recall exercise to complete 6 hours after internalizing a plan to gauge their recall performance for the plans. After 6 hours, the app delivered a reminder to the children to remind them of the assignment. The screen instructed them to jot down their plan as they recalled it. To guide children and decrease typing strain, input areas for the 'if' and 'then' parts of the plan were separated. To rate the responses, a two-step process was employed—first, an automated rating, followed by manual rating for responses that could not be confidently evaluated automatically. For the automated evaluation, we tokenized the sentences, deleted stop words and punctuation and assessed as erroneous those that had a residual input length of just one word or fewer. Subsequently, two raters manually classified the remaining replies as correct (1) or incorrect (0) based on a pre-registered criteria (see Biedermann et al., 2023).

If children attempted to use the app outside of these time constraints, the app displayed a message with instructions on the proper times to use the app for the study.

Data analysis

Statistical processing was carried out using R (R Core Team, 2021). To investigate the possible relationships between all variables, correlation analyses were performed using Spearman's test. Spearman correlation was used because not all measures met the criteria for Pearson correlation and we wanted to be consistent. Also, the goal of the correlation analyses was description; hence, we did not find a post hoc correction relevant in this case. The key inferences are made based on the linear mixed-effects model. To test the first hypothesis, differences in children's attitude towards using the three learning activities were explored using a linear mixed-effects model implemented in the 'lme4' package (version 1.1-28, Bates et al., 2015). In the mixed model, the comparisons were tested twice with conditions being dummy coded. In the first comparison, the puzzle activity was used as a reference, hence, emoji and reading activity was used as reference, hence, emoji and reading activity (see formula below).

To test the second hypothesis, we investigated if attitude towards the emoji activity contributed uniquely towards behavioural intention. A two-step hierarchical linear model was performed, with the first step including the puzzle and reading attitude scores as predictors and the second step adding the emoji attitude scores as a third predictor. To test the third hypothesis, based on previous literature and results of the correlation analyses (Table 1), we formulated a hypothetical model (see Figure 5) of relationships between the factors considered to influence behavioural intention (ie, attitude emoji, attitude puzzle, attitude reading and perceived enjoyment) and then performed a path analysis with parallel mediation to clarify the interdependent relationships between these factors using the lavaan package (v0.6-11; Rosseel, 2012). In the hypothetical path model, the three attitude factors (ie, attitude emoji, attitude puzzle and attitude reading) were used as predictors, perceived enjoyment was used as mediator and behavioural intention was used as outcome variable. Path analysis modelling was then performed using Maximum Likelihood as the estimator. To derive the 95% confidence intervals (CI) of estimated path coefficients, we applied bootstrap estimation with 20,000 resamples (Shrout & Bolger, 2002). In a follow-up control analysis testing, we included information technology (IT) literacy items (ie, IT age, IT duration and IT learning) and memory scores as possible confounders. The level of significance for all analyses was set at p < 0.05.

Comparison 1:

 $\text{ATTITUDE} = \gamma_{00} + (\gamma_{10} + \upsilon_{1j}) \bullet \text{DUMMY EMOJI}_{ij} + (\gamma_{20} + \upsilon_{2j}) \bullet \text{DUMMY READING}_{ij} + \upsilon_{0j} + \varepsilon_{ij}$

Comparison 2:

ATTITUDE = $\gamma_{00} + (\gamma_{10} + \upsilon_{1j}) \bullet DUMMY EMOJI_{ij} + (\gamma_{20} + \upsilon_{2j}) \bullet DUMMY PUZZLE_{ij} + \upsilon_{0j} + \varepsilon_{ij}$

RESULTS

Descriptive statistics

Table 1 summarizes participants' response values for attitude emoji, attitude puzzle, attitude reading, perceived enjoyment and behavioural intention to use. Descriptive results indicate that children made proper use of the different attitude scales (range: 1–5), the averages were around the mean of the scales for attitude emoji, attitude puzzle and attitude reading (see Table 1). Correlation results between participants' response scores revealed the existence of significant positive relationships between all of the factors (Table 1).

TABLE 1 Descriptive statistics of the participants (*N* = 103) and correlations for study variables.

Participants characteristics	Descriptive statistics mean (<i>SD</i>)	Attitude emoji	Attitude puzzle	Attitude reading	Perceived enjoyment	Behavioural intention
Attitude emoji	3.42 (0.94)					
Attitude puzzle	3.08 (0.86)	0.32***				
Attitude reading	3.11 (0.94)	0.51***	0.63***			
Perceived enjoyment	4.33 (0.77)	0.41***	0.35**	0.40**		
Behavioural intention	4.29 (0.78)	0.39***	0.22*	0.30**	0.65***	

Note: All model factors have a scale range of 1–5. Higher values indicate more positive attitude, perceived enjoyment or behavioural intention to use respectively.

*p < 0.05.

p <0.01. *p <0.001. 1457853, 2023. 5. Downbaded from https://hears.journal.ou/inel/hears.ywiley.com/doi/10.11111/bjet13314 by DIPF [Lebniz-Institut fuer Bildingsforsching und Bildingsforsching und

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Attitude towards the learning activities

First, we investigated if children show a more positive attitude (ie, composite score of perceived ease of use and perceived usefulness) towards the emoji activity than towards the puzzle and reading activity. As shown in Figure 4, children's attitude towards using the emoji activity was significantly more positive (M = 3.42, SD = 0.94) than their attitude towards using the puzzle activity (M = 3.08, SD = 0.86) or the reading activity (M = 3.11, SD = 0.94; $\beta = 0.33$, 95% CI [0.11, 0.54], p < 0.01), thereby providing support for H1.

Effect of attitude on behavioural intention

Second, following the outcome of the correlation analysis, we sought to investigate if children's attitude towards performing the emoji activity uniquely influences their behavioural intention to use the app. In the first step of the hierarchical regression model with attitude reading and attitude puzzle as predictors, only attitude towards the reading activity was significantly associated with behavioural intention (see Table 2). All else held constant, behavioural intention increased by 0.23 with each 1 *SD* increase in attitude towards the reading activity. The first model showed that attitude towards the reading and puzzle activities together only accounted for 6% (Adjusted *R*-squared) of the variation in behavioural intention. In the second step of the model with attitude emoji added as a predictor, only



FIGURE 4 Attitudinal differences towards the learning activities. Grey dots = raw data points indicating average scores per participant for each activity. Red dots = predicted values with 95% confidence interval.

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	Model 1			Model 2	Model 2			
Variable	В	CI	р	В	CI	p		
Attitude puzzle	-0.01	-0.26 to 0.23	0.921	0.03	-0.20 to 0.26	0.787		
Attitude reading	0.23	0.02 to 0.45	0.034*	0.06	-0.18 to 0.29	0.638		
Attitude emoji				0.31	0.11 to 0.50	0.002**		
R ² /R ² adjusted		0.081/0.059			0.180/0.149			
F for change in R ²					9.752	0.002**		

TABLE 2 Hierarchical regression table (*N* = 103).

Note: CI = 95% confidence interval. **p* < 0.05. ***p* < 0.01.

attitude towards the emoji activity was significantly associated with behavioural intention. All else held constant, behavioural intention increased by 0.31 with each 1 *SD* increase in attitude towards the emoji activity. Adding attitude towards the emoji activity to the model led to a significant increase in explained variance, (*F change* (1, 82) = 9.752, *p* = 0.002), which was now 15% (adjusted *R*-squared). Taken together these outcomes suggest that children's attitude towards performing the emoji activity uniquely and positively contributes to their behavioural intention to use the app, thereby providing support for H2.

Perceived enjoyment as a mediator of the effect of attitude on behavioural intention

Lastly, we investigated if the impact of the children's attitude towards performing the emoji activity on their behavioural intention to use the educational app is mediated by their perceived enjoyment of the app. In the mediation pathways from attitude towards the emoji activity, attitude towards the puzzle activity and attitude towards the reading activity to behavioural intention, results showed that attitude towards the emoji activity was positively related to perceived enjoyment ($\beta = 0.38, 95\%$ CI [0.08, 0.49], p = 0.004), which in turn was positively related to behavioural intention (β = 0.52, 95% CI [0.31, 0.74], p = 0.000; Figure 5). As shown in Figure 5, given that the direct effect of attitude towards the emoji activity on behavioural intention in the model was not significant ($\beta = 0.17, 95\%$ CI [-0.03, 0.32], p = 0.097), perceived enjoyment fully mediated the relationship between attitude towards the emoji activity and behavioural intention (magnitude of indirect effect: β perceived enjoyment = 0.20, 95% CI [0.03, 0.29], p = 0.015). Attitude towards the puzzle activity ($\beta = 0.21, 95\%$ CI [-0.05, 0.41], p = 0.116) and attitude towards the reading activity ($\beta = -0.01$, 95% CI [-0.21, 0.24], p = 0.945), on the other hand, were not significantly positively related to perceived enjoyment and, hence, showed no indirect effects on behavioural intention (supplement). These results provided support for H3. The standardized regression coefficients and covariance estimates of the model are depicted in Figure 5.

Control analyses

The self-concept factors involving IT age (β = 0.08, 95% CI [-0.15, 0.28], p = 0.446), IT duration (β = 0.15, 95% CI [-0.08, 0.44], p = 0.276) and IT learning (β = 0.11, 95% CI [-0.03, 0.27], p = 0.142) were included as external factors in the model post hoc, in order





FIGURE 5 Path analysis model depicting the relationship between attitude, perceived enjoyment and behavioural intention to use the app. All the coefficients (β) and covariance estimates are standardized. Complete model output is included in the supplementary material. *p < 0.05; **p < 0.01; ***p < 0.001.

to determine if they contributed towards explaining children's behavioural intention. None of the self-concept factors were significantly associated with any of the factors in the model. Including the self-concept factors or memory scores in the model did not affect the pattern of results previously reported for attitude towards using the emoji activity (see supplement).

DISCUSSION

An important concern when developing educational apps for children is to design learning activities that are interesting and engaging in the long term. Adopting a longitudinal design involving extended ambulatory assessments that provide for both a more reliable and externally valid measure of attitude, the current study investigated how learning activities that elicit different levels of enjoyment and engagement affect school children's acceptance of educational apps and their behavioural intentions to continue using them. By comparing three distinct app-based learning activities, we found evidence in support of the link between perceived enjoyment and behavioural intention. We additionally showed that perceived enjoyment mediated the effect that attitude towards the learning activities had on behavioural intention to keep using the app.

A further novel contribution of this research is the implementation of a learning activity that involved children representing the to-be-learned content with emojis. First, we found that children had the most positive attitude towards the emoji activity (confirming Hypothesis 1). Second, children's positive attitude towards using the emoji activity uniquely predicted their behavioural intention to use the educational app (confirming Hypothesis 2). Third, the effect of children's positive attitude towards using the emoji activity on their intention to use the app was mediated by their enjoyment of the app (confirming Hypothesis 3). These findings suggest that the emoji learning activity boosted children's enjoyment and led to a higher intention to continue using the app in comparison to standard learning activities of scrambling and reading. We discuss the implications of these findings in the direction of designing effective and enjoyable app-based learning activities which will foster children's acceptance of educational technology.



Fostering perceived enjoyment to foster children's acceptance of educational apps

Our findings provide support for the hypothesis that children's perceived enjoyment is an important contributor to their intention to use educational apps. Perceived enjoyment has been shown in a few previous studies to be a contributor both towards children's behavioural intention to use educational technology (Camilleri & Camilleri, 2019) and learning outcomes using educational technology (Espinosa-Curiel et al., 2020). Our study provides initial evidence that perceived enjoyment not only predicts children's behavioural intention, but also mediates the effect attitude towards specific learning activities may have on children's behavioural intention to use an educational app. In particular, we showed that the emoji learning activities. Perceived enjoyment over and above their attitude towards the other learning activities. Perceived enjoyment, in turn, predicted children's behavioural intention to use the educational app, thereby providing support for our third hypothesis. This result also provides evidence in support of the argument that perceived enjoyment could be considered a major contributor to children's usage of educational apps.

One pertinent question then remains—how can educational apps be made in such a way that they are both effective and enjoyable for children? Effective meaning that they are able to aid children achieve their learning goals, while still being enjoyable such that children still find them engaging or fun. Effective learning activities often involve desirable difficulties (Bjork & Bjork, 2011), which entail asking learners to actively generate instead of passively receiving learning content in order to foster the encoding and retention of this content. We have shown before that the emoji learning activity in which the to-be-learned content has to be represented with emojis and not just read, is effective for memorizing plans (see Biedermann et al., 2023). In the current paper, we could show that children had the most positive attitude towards the emoji activity, and that this attitude was uniquely linked to their enjoyment of the app and therefore to their intention to use it. These findings thus make a case for the use of emojis in app-based memorization activities among 4th to 7th graders because it can foster both children's learning and enjoyment.

Emojis can potentially increase engagement in educational apps by adding an emotional and visual element to the learning experience. This can make the content more relatable and interesting for learners, and also provide a way for them to express themselves. There are several theories of learning motivation that could potentially explain why emojis might lead to greater engagement. One of such theories is the Self-Determination Theory (Ryan & Deci, 2000), which proposes that people are more motivated to engage in activities that they perceive as being related to their personal interests and values, and that provide them with a sense of autonomy, competence and relatedness. Emojis might help to enhance feelings of relatedness by providing learners with a way to connect with the material on an emotional level, and by allowing them to express their own emotions and personality through their use of emojis. Another theory that could potentially explain the potential benefits of emojis in an educational context is the Socio-Cultural Theory of learning (Vygotsky, 1981; Vygotsky & Cole, 1978), which proposes that learning is an inherently social and cultural process that is influenced by the learner's social and cultural context. Emojis can help to create a more social and culturally relevant learning environment, by providing learners with a way to communicate and interact with one another in a more informal and expressive way.

Overall, the inclusion of emojis in learning activities within an educational app could potentially lead to greater engagement by adding an emotional and visual element to the learning experience, and by providing learners with a way to connect with the material on a personal level and express themselves.

Limitations and directions for future research

The current study has some limitations that should be kept in mind when interpreting the results. One major limitation lies in the extent of generalizability of the findings due to the sample investigated and task used. Participants included in the current study were mainly school children who fell within grade level of 4-7 (age range 9-14 years), with most of them being in the 5th grade. The task was to memorize a simple plan. It is paramount to test other age groups and memorization activities (eg, vocabulary) as well in order to be able to generalize these findings. A second limitation arises from the derivation of the measures (eq, perceived ease of use) investigated. The measures in the current study were derived from a low number of items-often just one item per construct-which may not be robust enough when considering the number of items employed in previous studies among adults (Alfadda & Mahdi, 2021; Hoareau et al., 2021; Yang & Wang, 2019). However, because the participants in the current study were children, we tried to estimate these measures without burdening the children too much. Moreover, single-item measures are commonly used in ambulatory assessment in order to reduce participant burden and decrease dropout (Gogol et al., 2014). A third limitation is that the learning conditions differed in terms of how long the sentence was visible to the children. In both the emoji and reading condition, the sentence was visible for as long as children wanted. In the puzzle condition, the sentence disappeared after a few sentences and children had to reconstruct it. It is possible that this procedural difference led some children to feel frustrated or pressured when completing the puzzle activity. Finally, our path modelling results are based on correlational data. Although difficult to do, future studies might focus on experimentally manipulating not just the different learning activities (as in our study) but enjoyment within these learning activities. The effect of different levels of enjoyment on actual usage and intention to use could then be directly observed. Ideally, this would be combined with a long-term follow-up that assesses the potential fade-out of usage.

CONCLUSION

The goal of this study was to further elucidate the relevance of enjoyable learning activities in fostering children's sustained usage of an educational app. The current study adopted the technology acceptance model in investigating how learning activities which elicit different levels of attitude affect school children's enjoyment and engagement of educational apps, and their behavioural intentions to use. In summary, findings from the study showed that first, children experienced a more positive attitude towards a customized learning activity based on the use of emojis compared to more standard learning activities. Second, a positive attitude towards using the emoji activity predicted their behavioural intention to use the educational app. Lastly, perceived enjoyment of the educational app considerably influenced the effect of a positive attitude towards using the emoji activity on behavioural intention to use the educational app among children. In conclusion, the study highlights the importance of children's enjoyment of an app for their intention to use it, and it provides a concrete example of how emojis can be used to boost enjoyment.

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CONFLICT OF INTEREST STATEMENT

There are no conflicts of interest to report.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in Open Science Framework at https://osf.io/zr6dq/?view_only=9a5a2bd8649649b6b70067b3ae0d5c55.

ETHICS STATEMENT

Ethics approval was obtained from the ethics committee of DIPF | Leibniz-Institut für Bildungsforschung und Bildungsinformation, approval number DIPF_EK_2021_33.

ORCID

Chimezie O. Amaefule b https://orcid.org/0000-0001-9822-3648 Jasmin Breitwieser https://orcid.org/0000-0002-0337-7159 Daniel Biedermann b https://orcid.org/0000-0001-9219-222X Lea Nobbe b https://orcid.org/0000-0002-5400-1952 Hendrik Drachsler b https://orcid.org/0000-0001-8407-5314 Garvin Brod b https://orcid.org/0000-0002-7976-5609

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