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Design and implementation of the feedback module for the SmartFC Flipped Classroom Platform

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Abstract

SmartFC (a web-based learning activity management platform) is an activity management system designed to support the flipped classroom methodology in secondary education through the creation and management of activities using OER (Open Educational Resources), even in low-connectivity environments, allowing users to access information via the web interface (using a browser on a computer or mobile device) and via the mobile app (using a program that can be downloaded and installed on a smartphone or tablet). The system provides teachers with various tools to facilitate the implementation of this methodology in their classes; it offers administrators management options; and it allows students to complete their school activities. Given that the flipped classroom learning path does not include a moment to provide feedback to students after completing the entire activity (viewing content, workshop, and assessment) and that the SmartFC platform is supported by this methodology, there is a need to design and implement this module, which allows and helps students to clarify doubts, demonstrate the solutions to the proposed exercises, after completing them, identifying what they have achieved, what they still need to understand, and thus receive guidance regarding the content and analysis of their work based on their results.

Keywords: Health and wellness tourism, Thermal spa, Motivations of the thermal spa, constraints of the thermal spa

1. Introduction

In recent years, the use of ICT has supported both distance and in-person education, becoming a key tool for students' educational development (Aguilera-Ruiz et al., 2017). The impact of ICT on society has allowed distance education to grow exponentially (Long & Brown, 2011), driving the widespread use of various virtual learning tools (e-learning), which require the implementation of Learning Management Systems (LMS). With these tools, teachers can share information and content, manage academic activities, and monitor their students' learning process (Sánchez Chero, 2017). Against this backdrop, new educational strategies and methodologies have emerged, such as the "flipped classroom," which seeks to combine traditional classroom settings with a virtual environment (Salinas Ibáñez et al., 2018), carrying out activities such as assignments, workshops, and assessments.

The Flipped Classroom (FC) model stands out among b-learning strategies (García Aretio, 2013), having gained prominence in recent years in response to the need to transform the traditional learning system and adapt to modern contexts, particularly for 21st-century students. This model emphasizes the acquisition of knowledge primarily through practical means rather than theoretical ones, outlining two phases in the student's learning process: i) the student completes activities before class (at home) using study materials provided by the teacher (usually via ICT tools). ii) the work carried out in the classroom becomes a time for discussion and interaction between students and the teacher, where the priority is not

theoretical content, but rather learning in a practical way through workshops, discussions, group work, and problem-solving (Griffiths & Villarroel, 2016). Thus, the flipped classroom aims for students to take on an active self-learning role, using time outside the classroom (Vidal Ledo & others, 2016) to explore and analyze the content previously provided by the teacher, generating questions and critical perspectives that will be discussed and resolved in class.

SmartFC (a web-based learning activity management platform) is an activity management system designed to support the flipped classroom methodology in the context of secondary education. It operates by creating and managing activities using OER (Open Educational Resources). One advantage is its ability to operate in low-connectivity environments, allowing users to access information via the web (using a browser on a computer or mobile device) and via the mobile app (a program that can be downloaded and installed on a smartphone or tablet). The system provides teachers with various tools to facilitate the implementation of the methodology in their classes, offers administrators management options, and allows students to complete their schoolwork.

Despite the features offered by the SmartFC tool, it has been noted that it lacks a feedback module where students can review the solutions to each of the exercises (in the workshops and assessments). Given the flipped classroom learning model, this feedback is typically provided in person in the classroom between the student and the teacher.

Most research on feedback in the flipped classroom (Lozano Martínez & Tamez Vargas, 2014) indicates that this activity can provide insights into teaching methods, the level of content comprehension, and the level of learning achieved by each student. Feedback allows students to clarify their doubts and concerns and demonstrate their solutions to the exercises assigned by the teacher, identifying what they have understood and where they have weaknesses. Based on the results obtained, the teacher and students focus their efforts on the content that needs reinforcement. This process generally takes place in the classroom (face-to-face) and helps improve student performance (Peña et al., 2017). Currently, there have been several scientific and technological advances in the flipped classroom methodology; however, there is a lack of an immediate and systematic feedback process.

This raises the following research question: How can feedback from a flipped classroom activity be shared on SmartFC?

The purpose of this article is to present the design and implementation of a feedback software module for the SmarFC platform, which allows students to clarify their doubts and immediately view the solutions to the proposed exercises. In addition, this contribution helps optimize teachers' work time and provides a tool to aid decision-making in teaching and learning processes. The module was evaluated through usability testing to assess the tool's performance in terms of comprehensibility, ease of use, functionality, and user appeal.

The article is structured as follows: Section 2 describes related work. Section 3 presents the proposed methodology for developing the feedback module of the SmartFC platform. Section 4 presents the results of the case study, and finally, Section 5 presents the conclusions.

2. LITERATURE REVIEW

The state-of-the-art shows that the flipped classroom model, combined with effective feedback processes and the use of ICT tools, has a positive impact on learning at various educational levels. Various studies agree that feedback, especially when it is frequent,

personalized, or technology-mediated, improves students' academic performance, motivation, and autonomy (Thai et al., 2017), (Buhl-Wiggers & Hardt, 2019), (Quispe Maraza et al., 2019). Strategies such as sending "reminders" via email, automated feedback (micro-feedback), and the use of digital platforms increase engagement with content and facilitate the tracking of academic progress (Sarpparaje, 2018), (Esteve-Faubel et al., 2017).

Furthermore, comparative studies between traditional models and the flipped classroom show that the latter increases pass rates, enhances skill acquisition, and allows for more time to be devoted to individualized feedback, although it requires greater teacher effort (Maarek & Kay, 2015). It has also been shown that implementing the flipped classroom improves student satisfaction and the effectiveness of in-person classes (Ramírez & Suárez, 2017).

On the other side, the use of ICT tools such as LMS platforms, WebQuests (Sánchez & Trigueros, 2017), digital forms (Esteve-Faubel et al., 2017), and gamification apps such as Kahoot and Quizizz (Quispe Maraza et al., 2019), enhances assessment and feedback processes, making them more interactive and effective. These technologies facilitate self-directed learning, collaborative work, and communication between teachers and students (Díaz Pinzón, 2017).

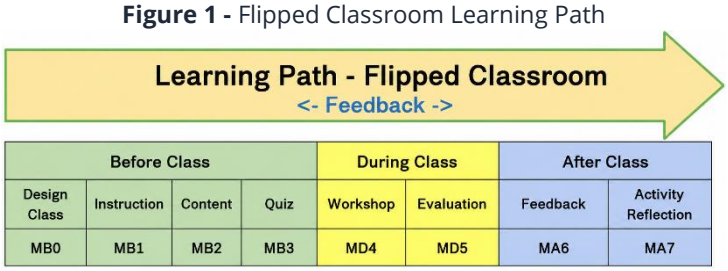
Finally, studies highlight that feedback not only influences academic performance but also motivation and the development of meaningful learning, especially in the early stages and when the family is involved. Also, evidence points to its role in improving teachers' assessment practices and in shaping the learning process. Overall, the literature supports the integration of the flipped classroom, feedback, and ICT as a comprehensive pedagogical strategy to improve teaching and learning processes (Del Pino et al., 2016).

In this section, it is important to understand SmartFC: It is an activity management system designed to support the flipped classroom model in secondary education by creating and managing activities using OER (open educational resources). It consists of two applications:

- **SGAFC**: A web application for teachers (it allows them to create and manage academic activities designed for the flipped classroom model).
- **SmartFC-App**: A mobile app for students to complete the activities assigned by their teachers; one of its key features is that it works with or without an internet connection, allowing students to begin their academic work at home.

The flipped classroom activity consists of 8 stages (M0...M7), divided into 3 phases (Before, During, and After). As shown in Figure 1.

Figure 1 - Flipped Classroom Learning Path



Phase 1. The "Before" Phase: (M0 to M3). (M0) is the time the teacher spends planning the lesson; this is when the objectives are defined, the OER to be shared is selected, and the workshop that students will carry out in class is designed. (M1 to M3) are activities that the student completes at home before class: (M1) Introduction, instructions, and objective of the activity; (M2) Perhaps the most important part of the model, the student views the OER on

their mobile app; (M3) The student takes a quiz (not a knowledge test) with questions where the teacher will verify how closely they watched the video. At this point, the student can identify and ask questions about any points in the video that were not clear to them.

Phase 2. The "During" Phase: (M4 and M5) These are the activities the teacher leads in class. By this point, the teacher will already have all the information about what the students did at home, allowing them to structure the lesson based on the assessment that SmartFC helps them compile. (M4) It is proposed that the class be made more engaging through a *hands-on workshop, where students resolve any questions they had while watching the video, together with their teacher and classmates. (M5) *Assessment: Once the workshop is complete and all questions have been addressed, it is proposed that an assessment be conducted, preferably based on the workshop.

Phase 3. Follow-up: (M6 and M7). In (M6), the teacher is encouraged to provide students with feedback on the entire flipped classroom activity—specifically, the quiz and assessment results, and, if desired, the workshop—so that students can review at home and/or in class the areas where they struggled and need to improve. (M7) This is the moment when the teacher, using the SGAFC metrics dashboard, reflects on the entire activity, both in terms of individual and/or overall student performance. In this way, the teacher can assess how effective the educational process was.

3. METHODOLOGY

This research employed the iterative process methodology described in (Pratt & Bright, 2009), which provides a framework for designing and implementing the SmarFC feedback module. This tool proposes four (4) phases (observe, identify, develop, and test), allowing for either a linear or iterative approach:

Observe: The problem is identified through direct contact with the client. A descriptive survey was administered to 20 teachers and 25 students to determine feedback needs (type, mandatory status, timing, and format), as well as to define metrics and requirements for the module in SmartFC.

Identify: The defined requirements are validated, and the development of a web and mobile application is proposed as a solution, using MongoDB, Angular, Node.js, and React Native.

Develop: A modular architecture (Rodas & Rodas, 2016) is defined, and the XP agile methodology (Joskowicz, 2008) is adopted for development. User-Centered Design (UCD) (Galeano, 2008) is used to validate user stories before implementing the solution.

Testing: Usability and user satisfaction are evaluated based on ISO 9241-11, using surveys. The goal is to ensure efficiency, effectiveness, and a positive user experience, given that poor usability hinders learning and leads to dissatisfaction (Alshehri et al., 2019).

4. RESULTS AND DISCUSSION

This section presents the results obtained from the development and implementation of the feedback module in SmartFC. To gather requirements and identify the main needs and functionalities that the module should have, a descriptive survey was administered to 20 teachers (83%) and a sample of 25 students at Rafael Pombo School in Popayán, Colombia. This allowed for the identification of three key findings:

1. 75% of respondents indicate that feedback is important in the Workshop, Quiz, and Assessment, Figure 2.

2. How students will view feedback for the two components (Quiz and Assessment), Figure 3.
3. Determine when the platform will display feedback for the Workshop, Quiz, and Assessment, Figure 3.
4. Students agree on the importance of seeing feedback on their activities, Figure 4.

Figure 2 - The importance of feedback at three key moments

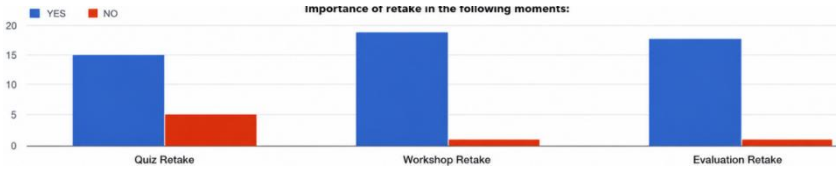


Figure 3 - The importance of feedback at three key moments

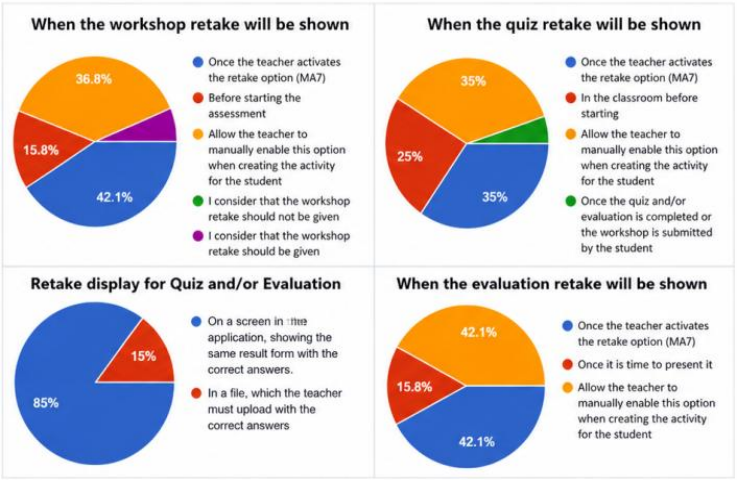
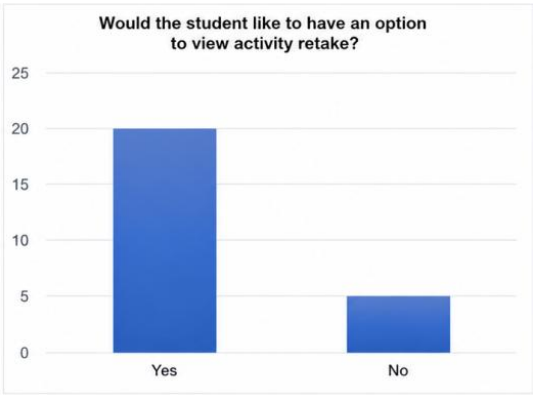


Figure 4 - View Feedback - Student



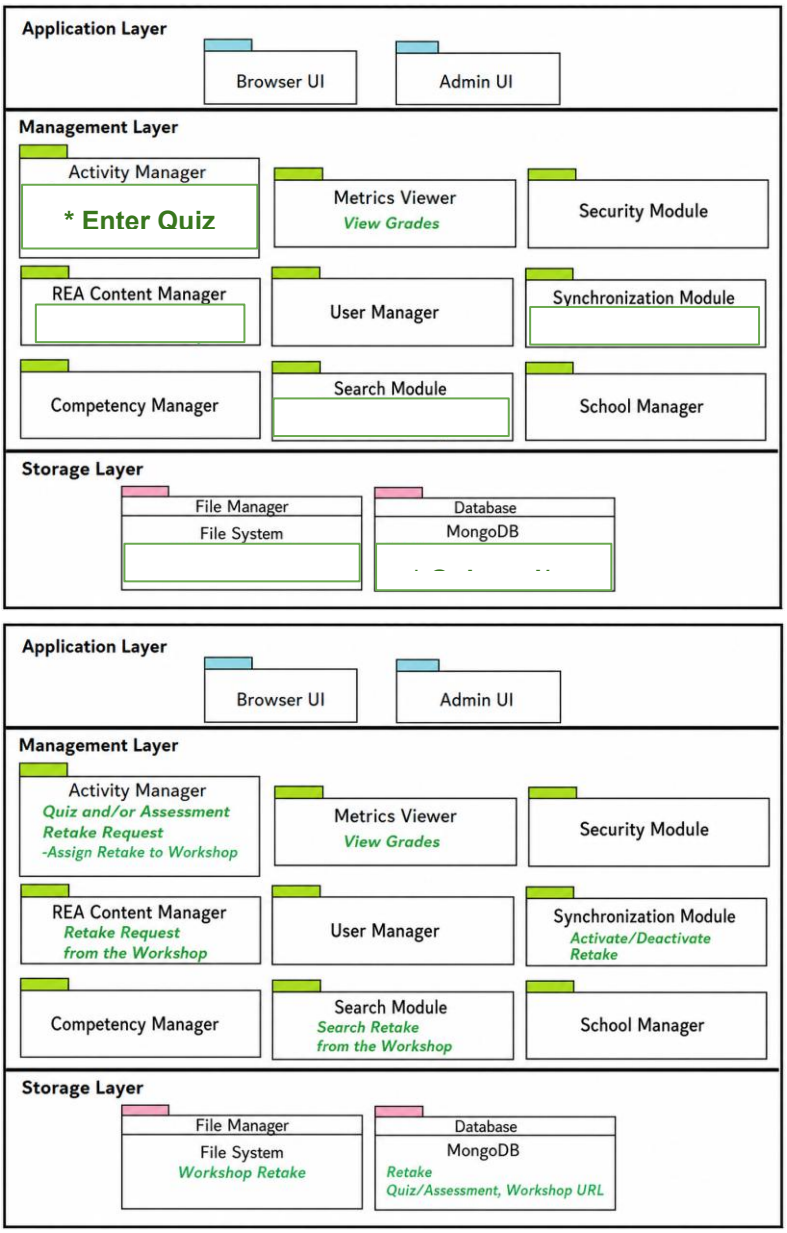
These results help establish a traceability matrix based on the user stories to be designed, to present the client with a working prototype that meets the requirements; see Table 1.

Table 1 - Traceability matrix for the feedback module of SmartFC

REQ. Creating the Feedback Module			
Id	**Rol**	**Use Case**	**Story User**
HU1	Teacher	Enter a comment or note for each quiz question.	As a teacher, I would like to be able to enter a comment or observation for each question on the quiz
HU2	Teacher	Enter a comment or note for each assessment question.	As a teacher, I would like to be able to enter a comment or observation for each question on the assessment
HU3	Teacher	Enable or disable feedback	As a teacher, I would like to be able to enable or disable workshop feedback
HU4	Teacher	Upload workshop feedback from the content manager	As a teacher, I would like to be able to upload workshop feedback via the content manager
HU5	Teacher	Assign feedback to the activity's workshop	As a teacher, I would like to be able to assign feedback to the activity's workshop
HU6	Teacher	Allow updates to the assessment for the created activity	As a teacher, I would like to be able to update the assessment for the created activity
HU7	Teacher	Create validations when creating the activity	As a teacher, I would like to be able to create validations when creating the activity
HU8	Teacher	Download the workshop feedback document	As a student, I would like to be able to download the workshop feedback document
HU9	Teacher	View the quiz feedback	As a student, I would like to be able to view the quiz feedback
HU10	Teacher	View the assessment feedback	As a student, I would like to be able to view the assessment feedback
HU11	Teacher	Be able to take the assessment and save the answers	As a student, I would like to be able to take the assessment and have my answers saved

Based on these requirements, the new feedback module has been designed to adapt to and integrate with the entire SmartFC ecosystem; Figure 5 shows a block diagram of the feedback module's implementation:

Figure 5 - View Feedback - Student



5. Case Study

To validate the development and implementation of the proposed feedback module, a case study was designed involving students and teachers at the school. The sample consisted of high school students (grades 9, 10, and 11), approximately 180 students out of a total of 360, and 24 teachers (100%), It is worth noting that the number of participants in this phase is much higher than the number of participants in the requirements gathering phase, since this phase involves evaluating the tool's performance. The following method was proposed as the main activity:

1. Preparation of the case study
2. Presentation and conduct of the case study.
3. Analysis of results.

1. Preparation of the case study:

Once the population of teachers and students was identified to validate the integration of the module, the Technology Acceptance Model (TAM) (Davis, 1989) was used as a tool for data collection. This model examines the population, acceptance, and usage behavior regarding information technologies, and determines a person's intention to use a technology based on its perceived ease of use and perceived usefulness; A questionnaire was designed to determine the characteristics of the population, ease of use, and perceived usefulness:

A. Demographic questions:

> **Teachers**: How old are you? How many courses do you teach? Are you familiar with the concept of a feedback classroom? Have you used the SmartFC platform?
> **Students**: How old are you? Do you have a smartphone? Do you have an internet connection? Have you used the SmartFC mobile app?

B. Questions about ease of use:

Teachers and students will be given a list of questions to answer on a scale of 1 to 5, where 1 is very difficult and 5 is very easy:

Teachers:

1. How easy was it to use the application in general as support for classroom instruction?
2. How easy was it to enter feedback for the completed activities (Quiz, Workshop, and Assessment)?
3. How would you rate the feedback entry process in terms of its structure and ease of use?
4. How easy was it to enter the general comments provided for each question in the quiz and assessment feedback module, with the purpose of clarifying doubts and reinforcing knowledge without requiring students to wait for face-to-face feedback?
5. After entering the feedback, how easy was it to achieve the objective of clarifying students' doubts regarding the activity?

Students:

1. How easy was it to use the application in general as support for classroom activities?
2. How easy was it to review and understand the feedback provided for the completed activities (Quiz, Workshop, and Assessment)?
3. How would you rate the way feedback is presented, considering its structure and ease of use?
4. Based on the general comments provided for each question in the quiz and/or assessment feedback, how easy was it to clarify doubts and strengthen your knowledge without having to wait for face-to-face feedback from the teacher?
5. After reviewing the feedback, how easy was it to achieve the objective of clarifying doubts regarding the activity?

C. Teachers and students were provided with a set of questions to be answered on a scale from 1 to 5, where 1 = Strongly Disagree and 5 = Strongly Agree.

Teachers:

1. Does using the application as support for classroom instruction help motivate students to participate in class activities?
2. Does entering feedback for completed activities help students improve their classroom performance by clarifying doubts and strengthening academic knowledge?
3. Is the method used to enter feedback for activities (Workshop, Quiz, and Assessment) understandable and well organized?
4. Do the general comments provided for each question in the Quiz and Assessment help expand the explanation of the correct answer, clarifying doubts without requiring students to wait for face-to-face feedback from the teacher?
5. Does the implementation of activity feedback increase students' interest in completing the activities, since it allows them to assess their level of knowledge and identify their mistakes?

Students:

1. Does using the application as support for classroom instruction help motivate me to participate in class activities?
2. Does reviewing the feedback provided for completed activities help me improve my classroom performance by clarifying doubts and strengthening my academic knowledge?
3. Is the way in which feedback is presented for activities (Workshop, Quiz, and Assessment) understandable and well organized?
4. Do the general comments provided for each question in the Quiz and Assessment help expand the explanation of the correct answer, clarifying doubts without requiring me to wait for face-to-face feedback from the teacher?
5. Does the implementation of activity feedback encourage me to complete the activities, since it allows me to assess my level of knowledge and identify areas in which I am making mistakes?

Likewise, the actions that each user must perform to interact with SmartFC and the new feedback module were identified:

Teacher Actions:

- Log in to SGAFC as a teacher.
- Upload the workshop.
- Upload the feedback content.
- Create a flipped classroom activity, assigning the corresponding workshop feedback.
- Activate the Workshop, Assessment, and Feedback stages (as deemed appropriate).

Students Actions:

- Log in to SmartFC-App as a student.
- Access the published and active learning activity.
- Complete the Quiz, Assessment, and Workshop activities.
- Navigate to the Feedback section once it has been activated by the teacher.
- Access the Metrics section to review the corresponding grade and performance results for the activity.

2. Case Study Presentation and Implementation:

The case study was conducted with both students and teachers. For each group, the following activities were carried out to familiarize participants with the flipped classroom model and SmartFC, explain how to use the platform, validate the operation of the feedback module, and collect data to determine the level of technology acceptance:

Student Group:

- Welcome and introduction.
- Explanation of the flipped classroom model.
- Download and installation of the application on mobile devices.
- Explanation of the implementation of the feedback module in SmartFC.
- Completion of the activity (Quiz, Workshop, and Assessment).
- Review of grades and results.
- Completion of the Technology Acceptance Model (TAM) survey.
- Closing remarks and acknowledgments.

Teacher Group:

- Welcome and introduction.
- Explanation of the flipped classroom model.
- Access to the SmartFC platform and authentication as a teacher.
- Explanation of the implementation of the feedback module in SmartFC.
- Upload of the workshop.
- Upload of the workshop feedback.
- Creation of a flipped classroom activity with the corresponding Workshop, Quiz, and Assessment feedback.
- Activation of activity visibility.
- Activation of the feedback components.
- Completion of the Technology Acceptance Model (TAM) survey.
- Closing remarks and acknowledgments.

During this second phase, the following objectives were achieved: dissemination of the flipped classroom model and SmartFC platform, training users to properly use the system, verification that the developed feedback module functions correctly, and administration of the planned surveys.

Data Collection:

Functionality Verification: To verify the correct operation of the application and its integration with the SGAFC, a series of tests were conducted to validate the recorded data. The results are described below:

- Student Metrics: Student metrics display each student's progress throughout the activity, along with the corresponding grades.
- Activity Metrics in SGAFC: The activity metrics provide the calculation of the average grades obtained in the completed activity, as well as the number of students participating in each stage of the learning activity.

3. Analysis of Results:

Once the case study was completed—in which teachers created flipped classroom activities and students participated in them—the results of the TAM surveys were analyzed to measure the degree of acceptance and perceived usage. Student results are shown in Figures 6 and 7.

Figure 6 - Questionnaire - Ease of Use.

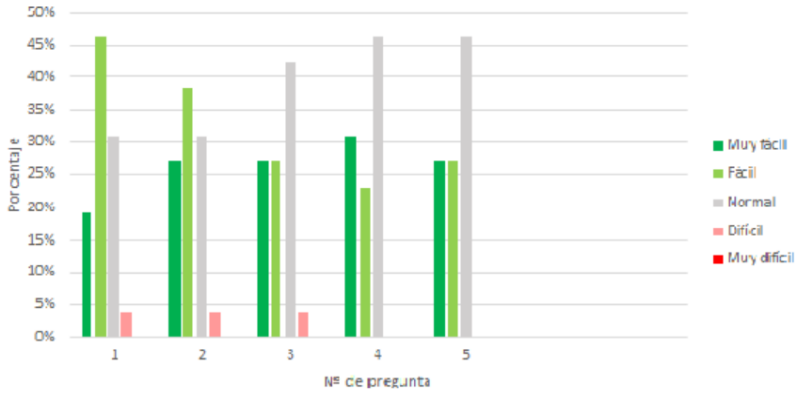
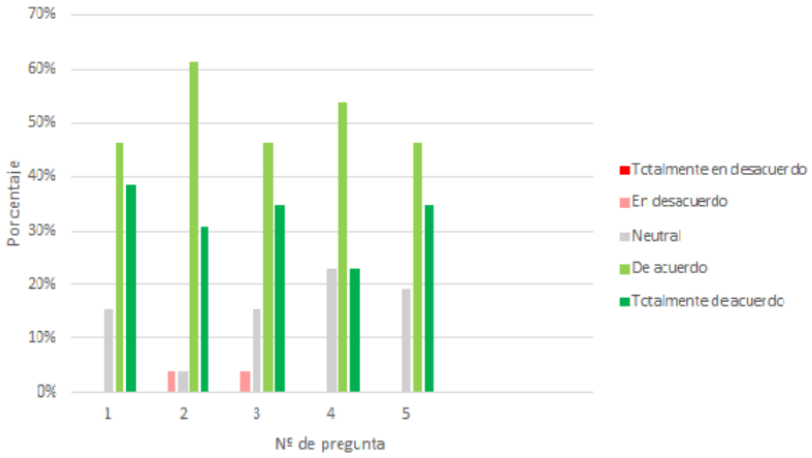


Figure 7 - Student Questionnaire – Usefulness.



Analysis of Student Results:

Perceived Ease of Use: A large percentage of students reported that SmartFC and its new feedback module were easy or very easy to use. Only a small percentage indicated that they found it difficult to use, while none reported it as very difficult. Therefore, it can be concluded that the application is not difficult for students to use.

Perceived Usefulness: The combined responses of Neutral, Agree, and Strongly Agree accounted for 100% of the responses for most of the survey questions. This finding supports the conclusion that students perceive the availability of feedback on their activities within SmartFC as highly useful.

The results obtained from the teacher surveys are presented in Figures 8 and 9.

Figure 8 - Teacher Questionnaire - Usefulness

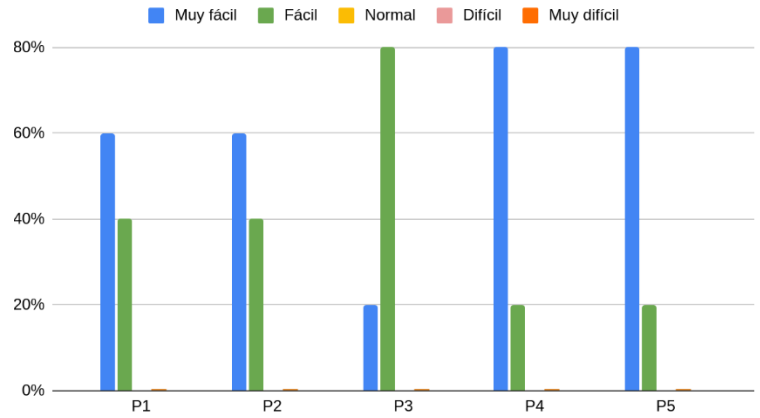
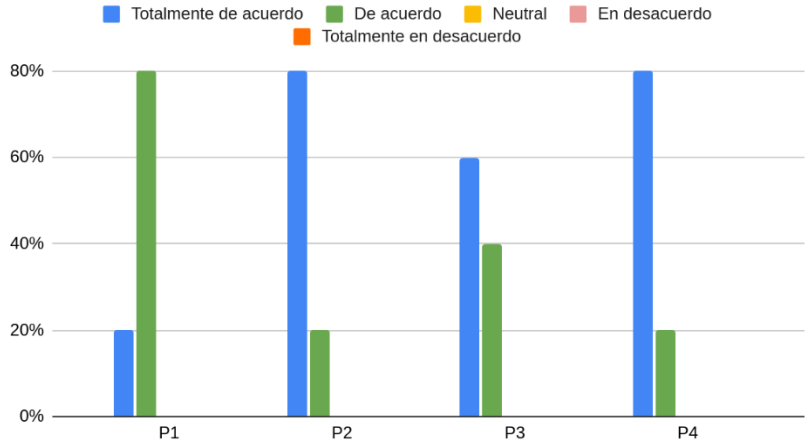


Figure 9 - Teacher Questionnaire - Usefulness



Analysis of Teacher Results:

Perceived Ease of Use: One hundred percent (100%) of the teachers stated that using SmartFC and its feedback module was easy or very easy. None of the participants reported experiencing difficulties or indicated that the system was difficult to use.

Perceived Usefulness: All teachers agreed that the new feedback module is highly useful for supporting student learning. None of the respondents considered the module to be ineffective or lacking usefulness.

6. Conclusions

Following a review of the literature on the flipped classroom strategy and the implementation of feedback, it was found that most studies focus on providing feedback to teachers, evaluating the methodology and the knowledge imparted to students; however, there is no specific feedback for students that identifies their mistakes in completing worksheets and/or assessments.

Furthermore, it was found that some studies use personalized feedback, providing a specific evaluation for each student—which is a labor-intensive task for the teacher—but do not offer general feedback.

All studies utilize ICT tools, many of which are not specifically designed to support the FC model, especially in environments with limited internet access. This research focuses on providing students with connectivity issues with a module that enables feedback.

Regarding ease of use, a large percentage of both students and teachers affirm that both SmartFC and its new module are easy to use; they also find it very useful in their teaching and learning processes.

The feedback module has proven effective in achieving its objective, both for teachers and in the student app; it thus ensures that the educational activity receives the appropriate feedback at the time the teacher deems appropriate.

As an educational application for both connected and unconnected contexts, SmartFC proves to be very convenient for students to make the most of their free time, even among a large student population.

Future projects

As future work, several improvements to the SmartFC ecosystem have been identified to provide better services for both teachers and students:

- Implement a web version of the mobile application to expand its accessibility across a wider range of devices and promote interoperability between platforms.
- Develop a mobile version for iOS devices.
- Implement a dynamic form for the Quiz component.
- Incorporate an autosave feature during the activity creation process, making the software more user-friendly and improving the overall user experience.

References

Aguilera-Ruiz, C., Manzano-León, A., Martínez-Moreno, I., Lozano-Segura, M. C., & Casiano Yanicelli, C. (2017). El modelo Flipped Classroom. *International Journal of Developmental and Educational Psychology. Revista INFAD de Psicología, 4*(1), 261. https://doi.org/10.17060/ijodaep.2017.n1.v4.1055

Alshehri, A., Rutter, M., & Smith, S. (2019). Assessing the relative importance of an e-learning system's usability design characteristics based on students' preferences. *European Journal of Educational Research, 8*(3), 839–855. https://doi.org/10.12973/eu-jer.8.3.839

Buhl-Wiggers, J., & Hardt, D. (2019). *Nudging in blended learning: Evaluation of email-based progress feedback in a flipped classroom information systems course*. ECIS 2019 Proceedings.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340. https://doi.org/10.2307/249008

Del Pino, B., Prieto, B., Prieto, A., & Illeras, F. (2016). *Utilización de la metodología de aula invertida en una asignatura de fundamentos de informática*.

Díaz Pinzón, J. E. (2017). Edmodo como herramienta virtual de aprendizaje. *INNOVA Research Journal, 2*(10), 9–16. https://doi.org/10.33890/innova.v2.n10.2017.447

Esteve-Faubel, J. M., Molina Valero, M. A., Botella Quirant, M. T., Faya-Alonso, Ú., & Esteve Faubel, R. P. (2017). Innovaciones de evaluación: Google Forms como herramienta de evaluación y retroalimentación de los aprendices. In *Memòries del Programa de Xarxes-I3CE* (pp. 1993–2004).

Galeano, A. R. (2008). Diseño centrado en el usuario. *Revista Q*.

García Aretio, L. (2013). *Flipped classroom: ¿B-learning o educación a distancia?*

Griffiths, L., & Villarroel, R. (2016). *Implementación del modelo de aula invertida para el aprendizaje activo de la programación en ingeniería*.

Joskowicz, J. (2008). *Reglas y prácticas en eXtreme Programming*. Universidad de Vigo.

Long, A. C., & Brown, L. P. (2011). Modelling the geometry of textile reinforcements for composites: TexGen. In P. Boisse (Ed.), *Composite reinforcements for optimum performance* (pp. 239–264). https://doi.org/10.1533/9780857093714.2.239

Lozano Martínez, F., & Tamez Vargas, L. (2014). *Retroalimentación formativa para estudiantes de educación a distancia*.

Maarek, J. M. I., & Kay, B. (2015). Assessment of performance and student feedback in the flipped classroom. In *ASEE Annual Conference & Exposition*. https://doi.org/10.18260/p.23602

Peña, B., Zabalza, I., Usón, S., Llera, E. M., Martínez, A., & Romeo, L. M. (2017). *Experiencia piloto de aula invertida para mejorar el proceso de enseñanza-aprendizaje en la asignatura de termodinámica técnica*. III Congreso Nacional de Innovación Educativa y Docencia en Red (IN-RED 2017). https://doi.org/10.4995/INRED2017.2017.6868

Pratt, K. S., & Bright, H. (2009). Design patterns for research methods: Iterative field research. In *AAAI Spring Symposium: Experimental design for real* (pp. 1–7).

Quispe Maraza, B., Paz Cuadros, L., Gambarini Fernandez, W. C., Palomino, Y. A., & Quispihuanca Chillitupa, A. A. (2019). Análisis de las herramientas de gamificación online Kahoot y Quizizz en el proceso de retroalimentación de aprendizajes de los estudiantes. *Revista Referencia Pedagógica, 7*(2), 339–362.

Ramírez, B. F. M., & Suárez, C. A. H. (2017). Las aulas invertidas: Una estrategia para enseñar y otra forma de aprender física. *INVENTUM, 12*(22), 42–51.

Rodas, J. I., & Rodas, G. R. S. A. (2016). Creación de una arquitectura utilizando UML en la implementación de un LEDI. *Entre Ciencia e Ingeniería*, 15–23.

Salinas Ibáñez, J., De Benito Crosetti, B., Pérez Garcías, A., & Gisbert Cervera, M. (2018). Blended learning, más allá de la clase presencial. *RIED. Revista Iberoamericana de Educación a Distancia, 21*(1), 195–213. https://doi.org/10.5944/ried.21.1.18859

Sánchez Chero, M. J. (2017). Implementación de un sistema de gestión del aprendizaje para los colegios secundarios de Utcubamba-Amazonas. *TZHOECOEN, 9*(1), 70–80. https://doi.org/10.26495/rtzh179.121307

Sánchez, D. O., & Trigueros, I. (2017). Las WebQuests y los MOOCs en la enseñanza de las ciencias sociales y la formación del profesorado de educación primaria. *Revista Electrónica Interuniversitaria de Formación del Profesorado, 20*(2), 205–220. https://doi.org/10.6018/reifop.20.2.258551

Thai, N. T. T., De Wever, B., & Valcke, M. (2017). The impact of a flipped classroom design on learning performance in higher education. *Computers & Education, 107*, 113–126. https://doi.org/10.1016/j.compedu.2017.01.003

Vidal Ledo, M., et al. (2016). Aula invertida, nueva estrategia didáctica.

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Conceptualization, FSG, JEH, LV, JE-G, ZH-A; methodology, FSG, JEH, LV, JE-G, ZH-A; software, FSG, JEH, LV, JE-G, ZH-A; validation, FSG, JEH, LV, JE-G, ZH-A; formal analysis, FSG, JEH, LV, JE-G, ZH-A; investigation, FSG, JEH, LV, JE-G, ZH-A; resources, FSG, JEH, LV, JE-G, ZH-A; data curation, FSG, JEH, LV, JE-G, ZH-A; writing—original draft preparation, FSG, JEH, LV, JE-G, ZH-A; writing—review and editing, FSG, JEH, LV, JE-G, ZH-A; visualization, FSG, JEH, LV, JE-G, ZH-A; supervision, FSG, JEH, LV, JE-G, ZH-A; project administration, FSG, JEH, LV, JE-G, ZH-A; funding acquisition, FSG, JEH, LV, JE-G, ZH-A. All authors have read and agreed to the published version of the manuscript.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

All the data required for this research is recorded in this document.

ETHICS STATEMENT

The manuscript does not provide information regarding ethics committee approval, informed consent, or other ethical procedures relating to the participation of human subjects.

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