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Digital portfolio: a tool for learning physics

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Abstract. The digital portfolio is a student-student, student-teacher interaction tool where formative assessment plays an important role in the learning of physics, with which the progress of students is monitored, the entire training process is evaluated and supported of the student, according to the planning and contents of the physics course. Therefore, this article describes the use of the digital portfolio as a tool for learning in students of a teacher training program in natural sciences and environmental education at a public university in Colombia. It is a quantitative study with a non-experimental design. The research subjects were students taking the subject of basic physics. The results indicate that students perceive the portfolio as a tool that allows monitoring and reflection of their learning and favor the integration of what they have learned, which supports the use of this tool, in accordance with the results of evaluation of the students' formative process. However, the use of the portfolio requires a continuous process of change and innovation, monitoring and permanent feedback between the teacher and the students.

1. Introduction

The digital portfolio is a tool that aims to bring together the work done by the student, which makes it a form of evaluation of their learning process, both for the teacher and for the student themselves. Indeed, the portfolio, as well as being consistent with active and responsible learning, constitutes a vehicle for self-assessment [1,2]. To all this we must add its great functionality as an instrument for assessment, both formative and summative [3]. Through the micro-curriculum of the subjects, the portfolio is established as one of the main elements that guide the student's activities. Thus, teachers propose various activities in the development of their courses, while providing tangible evidence of the same that the teacher promotes, in correspondence with the student's independent work [4].

On the other hand, assessment in natural sciences is an educational activity that aims to assess the development of students' scientific thinking and attitudes. The learning process designed by the teacher to teach students to perform activities such as: analyses data, categories, create categories, summaries and predict from practical activities can be assessed through the construction of a digital portfolio by the student. Also, physics subjects in any university program have recently undergone significant changes, caused by scientific progress and new technological developments. This makes the idea of creating a digital portfolio for students taking natural science subjects such as physics even more attractive.

In the context of the Universidad Francisco de Paula Santander (UFPS), San José de Cúcuta, Colombia, since the implementation of the teaching support platform (PLAD), the teachers of the



different academic program, including the bachelor's degree in natural sciences, make use of the digital portfolio as a tool that promotes learning and facilitates its evaluation; however, currently, trainee teachers produce as a portfolio a collection of documents that they deliver as a requirement to complete the evaluations, which does not reflect the participation of students in their learning.

Therefore, this study sought to answer the following questions: is there a link between digital portfolios and the learning and assessment of students in a physics course? And what is the level of appropriation of the teachers in training registered in the digital portfolio? From these questions it follows that the objective of the study is to characterize the perceptions about the use of the portfolio as a learning and evaluation tool in the subject of basic physics, to evaluate the development of the scientific skills of teachers in training. It also responds to the call of de Salazar & Arévalo [5] who, after conducting an analysis of the portfolio and its implementation as a teaching tool in the context of higher education, considered it essential to develop research that addresses it as an object of study and its relationship with professional competencies and successful educational practices.

2. Use of digital platforms as a digital portfolio

In higher education there has been a change in philosophy aimed at the appropriation of knowledge that promotes the development of skills and competences [6]; in turn, it is pointed out that a tool such as the portfolio plays an important role since it promotes the acquisition of new professional competences, thus achieving innovation in learning processes [7]. With this intention, the UFPS, implemented on Moodle, the PLAD as a resource for teachers to propose their various activities in the development of their courses, which also functions as a digital portfolio, a telematic tool that provides tangible evidence of the various activities that the teacher promotes in correspondence with the student's independent work [8]. This platform offers a didactic support to the development of the classes, that is, from it, the contents are systematized, and the construction of meaningful learning is promoted, and the commitment of teachers and students is achieved to resize the training process [9,10].

The digital portfolio is a tool that relies on various information and communication technology (ICT) resources to support the teaching-learning process, so knowing its benefits and operational difficulties [11], contributes to the development of didactic innovation, so it is pertinent to refer that this Pedagogical resource is a digital tool that promotes the development of individual work that promote integral development to improve student learning [9]. This is carried out following the suggestions of various authors [11-14], by means of instruments such as the elaboration of digital teaching support material oriented towards the student and giving priority to clarity and simplicity.

The motivational component that constitutes the assessment of learning can be used as the communicative axis of this information; exposition and analysis of the designed material, so that the teacher can verify the understanding of this by the students, which allows for feedback to clarify all kinds of doubts; establishing the minimum contents that the learning portfolio must include and the personalization of the contents of each student's digital portfolio.

Therefore, each student should be asked for a concrete proposal, coherent with the general framework specified, and individual tutoring should be established to enable the achievement of the competences that correspond to the objectives of the subject. This does not detract from the possibility of developing group portfolios. Through the face-to-face sessions and the documents available in the PLAD, the lecturer provides models, examples and references that allow the student to make estimates of the level of competence acquired, which are given in a sequential and progressive manner, so that it is easy and simple for the student to access and assimilate them.

Individual tutoring, which can be face-to-face or virtual, allows each student to contrast the estimates obtained through their own self-assessment. Once this has been done, each student's portfolio must be available in the PLAD to allow feedback from the teacher, which enables students to make the appropriate adjustments or modifications, so that both the teacher and the students can adequately develop the proposed assessment criteria; in this way, the portfolio is a tool that conducts both learning and formative evaluation [15].

2.1. Portfolio characteristics

As mentioned above, at the beginning of each subject a set of minimum elements is established that must be collected, in a personal and individualized way, in each digital portfolio available in the PLAD. Eventually, some of these elements may be the result of a collaborative activity. The nature of the contents of the portfolio, as proposed by [11-13], is established so that it can promote reflection and analysis of situations or problems related to the teaching and learning of the subjects, the development of proposals, which must be developed by integrating various competences, creativity with the proposed contents that must allow personalization according to the characteristics, preferences, and profile of each student. In addition to allowing continuous work, revision and progressive fine-tuning of the analyses, conclusions or proposals that are developed, timely tutoring to guide, help and avoid deviations due to mistakes on the part of the student and the recording of evidence of the competences acquired. In this way, the portfolio gathers a sequence of contents that describe, explain, or expose the evidence of the learning acquired, which may be presentations, spreadsheets, images, videos, among others.

2.2. Learning assessment

Formative assessment takes place in a natural way as each student progressively builds his or her personal portfolio; this monitoring is orienting and flexible and should encourage creativity [16]. Obviously, corrective interventions are also envisaged when deemed necessary; in this way, the portfolio usually shows evidence of the competences that each student is developing, so that the portfolio is the main instrument (but not the only one) for formative assessment [17]. Consequently, the summative assessment integrates, in a weighted way, the set of assessment indicators and allows the final individual qualification to be obtained. As a result, the student obtains a digital portfolio for each subject.

3. Method

In terms of methodology, the quantitative method was used. The type of study is descriptive, and its design corresponds to the non-experimental, as it allows us to analyze the use of the digital portfolio as a tool for learning; we worked with a single group due to the availability available for the study. The study population consisted of 47 student teachers enrolled in the bachelor's degree in natural sciences and environmental education at UFPS San José de Cúcuta, Colombia, who are taking the subject of basic physics. The results indicate that 72% of the participants are between 18 and 22 years old, 16% are between 23 and 27 years old, and 3% are older than 28 years. In addition, 61.7% are male and 38.3% female.

For the quantification of the degree of agreement of students to assess their experience with the digital portfolio as a learning and assessment tool, a questionnaire developed by Fielder [18] was adapted using a Likert scale with four response options, from completely disagree (1) to completely agree (4), which evaluated the digital portfolio in terms of the dimensions student learning (10 items), organization and assessment (7 items) and teacher participation and support (4 items) for a total of 21 items. The scale had a content validation based on expert review and a validation for each item in a pilot test on a group of students (10), who had worked with the digital portfolio. Cronbach's alpha for the scale obtained a value of 0.9 reflecting a high level of reliability for its application. After completion of the basic physics course, an online survey was sent to the students via institutional email and the PLAD platform (47). Twenty-eight surveys were completed, equivalent to 59.6%. The survey was voluntary and anonymous, and the data were handled with confidentiality.

For the questionnaire, the answers to each question per domain were expressed according to the score given by the Likert Scale. The results were analyzed using the SPSS statistical programmer, in which the data were processed, and tables and graphs were obtained with the information required to analyses and interpret the results. For the interpretation of the Likert-type numerical scale, following methodological guidelines from Hernández and collaborators [19], for this study, scores below 2.0 indicate a negative perception and, for scores above 2.0, a positive perception of the portfolio as a learning tool in the subject of physics will be considered.

4. Results and discussion

The results regarding the evaluations of the portfolio tool obtained in each dimension, verified the degree of satisfaction of the teachers in training in terms of their learning, organization and evaluation, and teacher participation and support. These results show that the tool facilitates interactions between students and teachers where formative assessment plays an important role in the learning of physics, with which the progress of students is monitored, the entire training process is evaluated and supported, according to the planning and contents of the physics course. Next, the statistics of the dimensions of the Likert scale are shown to quantify the degree of agreement of the students to assess their experience with the digital portfolio as a learning and evaluation. According to Table 1, the mean obtained is 2.7 on a scale of 1 to 4, which indicates that students mostly accept the use of the digital portfolio as a learning and assessment tool for natural sciences.

Table 1. Statistics of the Likert scale dimensions.

Dimension	Mean	Standard deviation
Student learning	2.8	0.9
Organization and assessment	2.6	0.8
Teacher participation and support	2.5	0.9
Average	2.7	0.9

4.1. Student learning

This dimension considers aspects to recognize learning or achievements acquired thanks to the portfolio, as well as the integration of previously acquired theoretical knowledge to the current subject. The students' perception for this dimension on the scale 1-4 is shown in the Table 2 from the averages for each item evaluated. According to Table 2, students agreed that the constructed portfolio was useful in their learning. Furthermore, they agree that the portfolio helped them to develop autonomous learning as well as to integrate theoretical knowledge into practice. However, some students do not consider it to be a learning tool.

Table 2. Averages for each item evaluated.

Item dimensions student learning	Average total
The portfolio built was useful in my learning	3.0
The portfolio helped me develop autonomous learning	3.0
The portfolio allowed me to integrate previous theoretical knowledge with scientific skills	2.7
The portfolio built allowed me to reflect on my pedagogical practice	2.8
The activities developed in the portfolio helped me to apply theoretical knowledge in the context of situations where science is applied	2.9
The activities carried out in the portfolio motivated me to seek additional information to solve them	3.1
The portfolio reflected my evolution during the development of subject	2.5
The portfolio encouraged me to solve problems using scientific reasoning	2.9
The analysis of the activities carried out with the portfolio will contribute to my professional practice	3.1
The portfolio should be eliminated as a learning tool	2.3

4.2. Organization and evaluation

This dimension considers aspects to understand the relevance of the proper use of the digital portfolio tool and its implementation. According to Table 3, for the students, the instructions received for the construction of the portfolio were clear and precise. Likewise, they consider the portfolio to be a complement to the traditional methods of evaluation that exist in the subject. Despite this, the students believe that the development of the portfolio affected the time dedicated to other academic activities, for which reason they consider it necessary to obtain more time for its construction and development.

Table 3. Shows the results of the survey.

Item dimension organization and evaluation	Average total
The portfolio as a learning and evaluation tool was known to me prior to this experience	2.3
The instructions received for the construction and use of the portfolio were clear and precise	2.6
The portfolio evaluation guidelines delivered at the beginning of the course served as guidance for the work	2.7
Performance evaluation where portfolio was used reflected my scientific skills	2.3
The portfolio is a good complement to traditional evaluation methods	2.7
The time I spent developing the portfolio affected the time spent on other academic activities	2.8
More time is needed in the subject for the development of the portfolio	3.1

4.3. Teacher participation and support

This dimension considers aspects to understand the importance of having the teacher to provide feedback on the design of the portfolio. Considering Table 4, regarding whether the feedback received from the teacher was adequate, the opinions among the students are divided, with no clear trend in favor of one position, the same happens with the teacher's commitment to the portfolio work and the understanding of the portfolio tool, which shows very little guidance in its construction.

In general terms, the teachers in training who take the physics subject consider that the use of the digital portfolio improves their learning, and that it is a tool that should be incorporated into the classroom [17] both from a theoretical and practical point of view, since it is a support to their classes and also contributes to their autonomous learning [20] and allows them to reflect on their learning and correct their mistakes [21], giving the opportunity to develop their scientific skills in solving problems and putting in play your creativity [22].

Likewise, the portfolio is a didactic strategy in which not only the work done during the course is compiled, but it also becomes an evaluation evidence of the students' learning process. In this sense, the use of this tool makes it possible to dynamize the educational process and therefore the reevaluation of the pedagogical space since it allows interaction between the students and the teacher [4]. Finally, the digital portfolio allows the student to show their progress and reflect on them; and that the teacher becomes a guide, motivator, advisor, guide, reviewer, and evaluator of the educational process [17].

Table 4. Shows the results of the survey.

Item dimension teacher participation and support	Average total
I received adequate feedback from the teacher, focused on the activities I carried out during the preparation of the portfolio	2.6
The teacher was committed to the portfolio work	2.3
The feedback received from the teacher was a contribution to the construction of my learning	2.6
The teacher understood the portfolio tool well, so he was able to guide me in its preparation	2.4

5. Conclusion

The digital portfolio has been used as an essential tool for learning the subject of basic physics in the bachelor's degree in natural sciences and environmental education. Thus, the teaching process contemplates specific procedures for the establishment of minimum contents, the specification of the specific contents of each portfolio, the digital formats, the formative and summative evaluation, and the evaluation of the teaching process itself. The implementation of the portfolio requires permanent monitoring and feedback from the teacher, in accordance with the dedication given by the students to its assembly. The results obtained have been satisfactory, which endorses the suitability of this tool which, nevertheless, is subject to constant modifications, in accordance with the results of the evaluation of the training process. The digital portfolio is a tool that enables the development of competences such as learning capacity, autonomy and personal initiative, creativity, reflective and critical thinking, and communicative and digital competences.

The present study only focuses on a population of teachers in training in natural sciences, but it could also be extended to students from other academic programs of basic sciences and engineering, as well as at previous levels such as secondary or higher education such as postgraduate studies, or in other types of populations, these being fields of study for future research. The instrument used can be adapted to these areas serving as a background. In addition, it is important to analyze the use and appropriation of the digital portfolio, expanding the number of participants. For the field of physics teaching, the available field of study is vast, so it is important to continue investigating, using tools such as the portfolio, assertions that can continue to contribute to educational innovation and science teaching.

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