Monitoring Students' Professional Competencies in PBL: A Proposal Founded on Constructive Alignment and Supported by AI Technologies

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Abstract—**This Research Full Paper presents a proposal founded on the Constructive Alignment Theory and supported by Artificial Intelligence (AI) technologies, aiming to monitor professional competencies in Computing Higher Education (CHE) based on Problem-Based Learning (PBL). Within CHE, there is a growing movement to change an educational paradigm that goes beyond knowledge-based education. Therefore, active learning methodologies such as the PBL, have become increasingly popular to develop student's technical knowledge, skills, and attitudes, translating in professional competencies. In this context, this research advocates the Constructive Alignment Theory by Biggs to monitor professional competencies in PBL experiences. Biggs suggests the alignment between the learning results from the student's perspective and the objectives defined by the teacher in the course planning. This follow-up can be done in various ways and include many data sources like the usual student feedback questionnaires. However, it requires a lot of effort from the teacher/pedagogical team and involves difficulties related to effort, workload, and time spent to make improvements. So, *how to monitor students' professional competencies in an automated way, having as references the Constructive Alignment Theory and the course planning*? For this, we propose an AI-based tool for processing student feedback, called *SkillSight,* helping teachers monitor competencies considering the learning outcomes. From Design Science Research cycles, the first evaluation results showed a good acceptance of this tool and suggestions for improvements, especially at the results visualization.**

Keywords—Computing Higher Education, Problem Based Learning, PBL, Constructive Alignment, AI, Professional Competencies

I. Introduction

Within Computing Higher Education (CHE), there is a growing movement to change an educational paradigm that goes beyond knowledge-based education, with focus on the cognitive dimension of education [1]. Therefore, active learning methodologies based on practical experiences and human interactions, such as Problem-Based Learning (PBL), have become increasingly popular to develop students' technical knowledge, skills, and attitudes, enabling them to perform better professionally [2].

As a pedagogical approach, PBL promotes the construction of knowledge, skills development, and stimulation of attitudes, contemplating the cognitive, affective, and conative learning dimensions [3]. According to Bloom [4], the cognitive dimension is associated with knowledge and how it is used in our daily lives, including understanding, knowledge application, evaluating, and creating new knowledge. The affective dimension involves interpreting feelings, emotions, attitudes, values, and awareness related to learning [5]. On the other hand, the cognitive dimension is related to the learner's intentionality, the "volition to learn", which includes the definition of goals, directed efforts, monitoring, self-direction, and self-regulation. In summary, cognition looks at what is learned; the affective dimension emphasizes feelings about what is learned and the learning experience; the cognitive dimension looks at the intention to learn.

As a teaching and learning process, PBL emerges as a proposal that integrates these dimensions of learning through authentic problem-solving experiences. These experiences should have well-defined educational objectives continuously monitored, bearing in mind the learning evolution. This look at learning objectives and the regulation of learning is the primary motivation for this study. On the one hand, PBL favors student learning, bringing to the educational environment complex problems (objects) to be solved by teams (subjects) in constant interaction with the real-world environment (application domains). On the other hand, all these elements involve iterations that need to be mapped and continuously monitored through a comprehensive assessment model from different aspects and perspectives, going through all dimensions of learning, conative, affective, and cognitive.

In this context, PBL identifies with competency-oriented education, through a pedagogical approach that integrates learning dimensions, having as a reference the development of competencies in students. In this study, the term "competence" is defined by three attributes: knowledge, skills, and attitudes. So, it is necessary to monitor these attributes in students, considering this education model, aligning educational objectives to professional competencies.

Aiming for contributions in this context, this research is based on two theories. First, it is the Constructive Alignment Theory by Biggs to monitor professional competencies. This theory suggests the alignment between the learning results from the student's perspective and the objectives defined by the teacher in the course planning. The Activity Theory delimits a real learning context based on PBL and its elements, which involve the object (or objective), subject, mediating artifacts (evidence and tools), and teamwork (rules, community, and division of labor) [6].

Thus, the context in question is a PBL learning environment, where the teacher plans educational objectives and activities, bringing authentic problems as learning objects; and students perform these activities in groups towards problem-solving, providing feedback on their learning. In this context, the follow-up can be done in various ways and include many data sources like the usual student feedback questionnaires. However, this follow-up requires a lot of effort from the teacher or the pedagogical team since the teacher needs to adopt a continuous assessment model that captures several subjective aspects from these feedbacks, which are generally numerous. Thus, processing personal feedback aligning them with the development of competencies for improving learning involves difficulties related to effort, workload, and time spent to make improvements.

From these challenges and their context, this study proposes to answer the following research question: RQ) *How to monitor students' professional competencies in an automated way, having as references the Constructive Alignment Theory and the course planning*? For this, we propose developing and applying an AI-based tool for processing student feedback, called *SkillSight*, helping teachers monitor competencies considering the planned educational objectives. In this proposal, educational objectives and competencies were mapped for the CHE based on PBL.

This paper is organized into six sections. After this introduction, Sections 2 and 3 describe the primary theoretical references and related works, respectively. After that, Section 4 presents the research methodology. The AI-based tool SkillSight is presented in Section 5, including the results from the first evaluation. Finally, Section 6 presents the conclusions and future perspectives of this research.

II. THEORETICAL REFERENCES

A. *Competence-Based Education*

According to Chiavenato [7], competence is defined as the integration and coordination of a set of knowledge, skills, and attitudes that, in its manifestation, produce a differential performance. OECD [8] argue that competence is much more than just knowledge and technical issues; it involves the ability to solve complex demands through the recurrence and mobilization of different psychosocial resources, such as attitudes.

In the educational context, competency-based education is defined as a pedagogical approach that involves redefining the objectives of the program, the classroom, and experiential education concerning competencies or skills, focusing the course on developing the students' competencies. students [9]. This education model assumes that courses should not only transmit or acquire knowledge and techniques but focus on comprehensive skills that allow students to solve problems in different and complex contexts [10].

Furthermore, Brumm [9] also points out that competencies are transparent; all participants in the learning process understand the learning objectives and outcomes. Competencies provide students with a clear map and the navigation tools they need to move quickly towards their goals.

Traditionally related to a knowledge-based model, Computing Higher Education (CHE) shifts toward a competency-based model. Studies [10], [11], [12] present the use of competencies or competency-based education in teaching computing in several courses. Recently, the Computing curricula published by the ACM/IEEE [1] comprise the definition of competencies as the main characteristic of the courses (Computer Science, Computer Engineering, Information Systems, among others) and competence-based education as the primary teaching model.

In [1], the teaching model follows the definition of the competency model based on learning activities, which need to have a defined objective and be related to an actual application context. Based on this definition, the activities are applied and monitored, and after their conclusions, feedback and intervention/improvement proposals are generated.

B. *Constructive Alignment Theory: Educational Planning & Management*

To better understand this work, it is necessary to explain some fundamental concepts concerning the Constructive Alignment Theory: Educational objectives, learning activities, student assessment, and feedback. The educational objectives indicate what the student must learn in their learning process and how this knowledge will be achieved [13]. Generally, these objectives are defined as sentences composed of verbs, nouns, and gerunds. Educational objectives represent the actions and the cognitive process of students, besides the knowledge to be acquired by them, as described in [14].

Learning activities refer to activities that students must perform to achieve the goals defined by the teacher. Biggs and Tang [13] argues that learning activities should include reflections and moments of individual learning, collaborative work, group work, and practices with teachers.

Assessment and feedback are essential concepts of Constructive Alignment Theory. Through them, it is possible to verify what and how students are learning while sending the correct signals about the student's learning state. Regarding assessment, Biggs and Tang [13] highlights that some concepts are important in defining this process: the assessment must be authentic, that is, it must reflect the evaluations carried out in the real world; the assessment must be contextualized, that is, appropriate to the environment or situation in which it is being applied; the assessment must be holistic and analytical, that is, it must evaluate the student as a whole and under a constructive perspective, considering not only technical knowledge but also subjective and psychosocial aspects of the student.

Regarding feedback, the results of evaluations carried out by students are returned to them in a formative feedback format, which shows them how the learning process is taking place, where it has flaws, and how they can solve these flaws.

After clarifying the primary concepts, the Constructive Alignment Theory proposed by John Biggs [13, 15] can be better understood when defined as the alignment between the learning outcomes and what the student acquired during the unit with the objectives defined by the teacher in the planning of the course.

According to Biggs, alignment is carried out in three major stages: 1) definition of learning objectives and expected results; 2) definition of activities carried out during the educational unit; 3) the collection of feedback and the continuous evaluation of the class.

The Constructive Alignment Theory has important benefits for learning assessment [17, 18, 19], improvements in the teaching and learning process [16, 17], management of educational objectives and learning activities [18, 19], in addition to representing a curriculum quality assessment instrument [13].

C. Problem-Based Learning in CHE

PBL is an instructional model of constructivist teaching, which uses problem-solving as a motivation for learning [20]. Created by Barrows in the 1960s, it gained prominence as a methodological approach in medical education and, over time, was extended to other areas such as computing and engineering.

According to [2], the focal point of PBL is not the solution itself but the solving process used to propose solutions and the skills developed during this process. So-and-so [21] exemplifies several attributes that make up the competencies and can be fostered from the adoption and use of PBL in higher education: critical thinking, problem-solving, communication, leadership, and teamwork.

In line with the development of these competencies, there must be also means of evaluation that show evidence, enabling the monitoring of the student throughout the educational unit. In this sense, an authentic evaluation model is essential, which corroborates the recommendations presented by Biggs in [13].

Studies in [21], [22], and [23] use a competency-based education model together with parts of the Constructive Alignment Theory, contemplating essential elements: a curriculum model with educational objectives suited to the students' needs; an authentic assessment model, encouraging the use of assessment by aspects; collaborative activities; individual, peer and group reflections.

In [24], Santos (2017) proposes an authentic assessment model for Computer Education based on PBL, considering the assessment dimension of students, teachers, and the methodology itself. In the student assessment dimension, the model defines assessment aspects aligning educational objectives and professional skills based on Bloom's Taxonomy [4]. The study also shows how this model has positively monitored student learning in PBL experiences over more than ten years, from an assessment process based on formative and summative evaluations and continuous feedback.

D. Activity Theory: Learning by PBL Experiences

Regarding the evolution of the *PBL-SEE* model, the NEXT research group has included new assessment approaches, primarily associated with the conative dimension of learning, focusing on students' self-direction and self-regulation [25], [26]. These studies were motivated by the analysis in [25] that analyzed learning profiles in students within PBL experiences in computing education, using the Activity Theory, making it evident the difficulty of students regarding the aspect of learning intentionality. Thus, a subjective assessment was incorporated into the *PBL-SEE* model, using the Constructive Alignment Theory as a reference, involving three questions:

1) *In general terms, what did you learn from a technical and non-technical point of view in this educational cycle/module?*
2) *How do you see your performance within your team, in terms of your participation and collaboration in the problem-solving process?*
3) *What do you intend to do to maintain (if goals are met) or improve your performance?*

This assessment is called "Learning Reflection", and it is applied at the end of each learning module/cycle within the educational unit. The results of the reflection assessment brought opportunities and challenges. As for opportunities, they showed the students' perception of competencies built within all three attributes (knowledge, skills, and attitudes). On the other hand, it demanded a high effort from the teacher in the processing of subjective individual feedback, collected in several moments during the course [27,28]. Another challenge that arises is the difficulty in the realization of the reflection assessment in large classes, once that a large amount of data is generated and needs to be processed [29]. The lack of time also impacted possible interventions in favor of learning improvements [29]. Thus, seeking solutions that could facilitate the interpretation and visualization of these feedbacks was a natural next step for the NEXT research group.

III. Related Work

Looking for solutions to the challenges mentioned in Section II.D, we found some works related to this study. The relationship between these studies and the current research occurs directly or partially regarding the use of constructive alignment from subjective student feedback, usage of topic modeling in competency-based education, or feedback processing through an automatic tool. Table I shows the proposals' main features, objectives, evaluation method, and shortcomings for comparison purposes.

The work of Ruseti, Dascalu, and Dobre [30] aims to propose an automatic method of extracting and summarizing the main student perceptions about several areas of a computing course using subjective feedback. The proposal is directly related to this research, which is also concerned with facilitating the understanding of key aspects of parts of the discipline, more specifically, learning. However, the authors' work is not concerned with qualitative evaluations of the tool, verifying the support of this methodology to the teaching-learning process with the teachers and its relationship with the formation of competencies.

Andersen, Hüttel, and Gnaur [31] aim to summarize students' perceptions of a PBL class of computing in distance education through topic modeling and text processing methods, presenting the key findings and the most relevant themes. This study does not aim to propose a tool/application that can be reused and is not concerned with competencies or constructive alignment.

Hodinott and Blackmoore ([28], [29]) present reports of carrying out constructive alignment from subjective feedback. The proposal is carried out from the questionnaires answered by the students. After this step, the results of the questionnaire were compared with the objectives and learning outcomes. They do not present evidence of the automation of the process by tools and point out that the time spent carrying out feedback processing and analyzing is considerable. In addition, the improvements detected could not be applied on time.

This study proposes an AI-based tool for processing subjective feedback from students, using topic and keyword modeling techniques, and named entity recognition (NER). We also apply this tool to authentic PBL experiences by performing qualitative assessments, detecting strengths, and possible future improvements. Table I presents the main characteristics of the studies related to this research, justifying the proposal of the SkillSight.

TABLE I. RELATED WORKS

References	**Characteristics**		
	Proposal	***Objective***	***Evaluation***
Ruseti, Dascalu, and Dobre [30]	Automatic feedback summarization method.	Interpret viewpoints more easily.	Qualitative assessment, without the presence of teachers.
Andersen, Hüttel, and Gnaur [31]	Summarization of students' perception.	Map process and delimit characteristics	No evidence
Hodinott and Blackmoore [28], [29]	Process for constructive alignment, based on subjective feedback.	Apply the process in different teaching modalities.	Qualitative assessment with a subjective questionnaire.
Current research	AI-based Tool for processing subjective feedback.	Help the teacher to carry out the monitoring of competencies.	TAM model and subjective questionnaire.

IV. RESEARCH METHOD

As discussed previously, the evaluation carried out by subjective individual feedback, the monitoring of competencies, and the Constructive Alignment require an enormous workload on the part of the teacher, both concerning the execution of the same, as well as in the communication and implementation of improvements in the current time of the educational unit. Therefore, this work has the following central research question: *RQ) - How to monitor students' professional competencies in an automated way, having as references the Constructive Alignment Theory and the course planning*?

Wieringa's Design Science Research (DSR) method [32] was used to answer this question, understand the problem, and devise a solution. The DSR consists of a problem-oriented method that bases and operationalizes research when the objective is to build and evaluate artifacts to obtain new, better, or desirable states. It was chosen because it is a problem-oriented method and has an iterative (cycle-based) approach to designing a tangible artifact. This method also recommends the use of a regulatory cycle that encompasses four stages: (1) Problem Investigation, (2) Solution design, (3) Design evaluation, and (4) Solution proposal (including implementation and evaluation). Thus, this study contemplates the description of two complete design cycles and a cycle in progress (as shown in Fig. 1), all with the four stages of the regulatory cycle: conception of the AI-based tool, the prototyping of the solution, and functional prototyping.

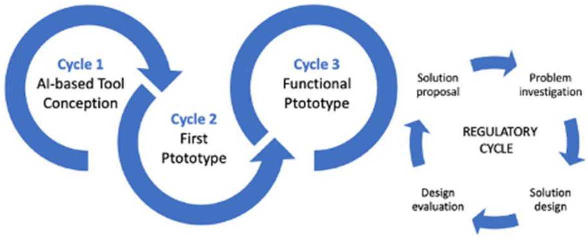

Fig. 1. DSR cycles.

Cycle 1 included the initial design of the tool when we understood the problem, alternatives of solutions, possible technologies, architecture, and initial design concepts. Having as initial motivation the challenges found in PBL experiences lived by the authors of the current study, in the problem investigation stage, we did a literature review that found the ways of carrying out Constructive Alignment and the possible problems related to it. As a result of this step, we found a list of possible challenges to be overcome, choosing the challenge related to the constructive alignment to monitor competencies. As justification, we highlight the diversity of definitions of competencies, the high workload on the part of the teacher, and the delay in implementing improvements. At this stage, we decided to use the Constructive Alignment carried out from the subjective feedback of the students, based on the results of the study in [13, 15]. In the solution design stage, we investigated forms of free text processing and their application in tools. As a result of this step, the technologies used, data sources, and the application's architecture were defined, as well as the first forms of visualization. In the Project Validation stage, the literature on free text processing in Portuguese was considered, considering PBL experiences in Brazil and the literature on text visualization in educational tools. We defined the proposed architecture in the solution proposal stage, and tests were carried out on the technologies with the specified data sources and the first views. In the Implementation evaluation stage, the NEXT Research Group evaluated the solution design based on design and data visualization techniques. The group concluded that the technologies used help the teacher in the Constructive Alignment to monitor competencies. The group also concluded that improvements were needed in the visualizations presented and their unification.

Cycle 2 involved prototyping the solution. We investigated information visualization forms, usability criteria for interfaces, and color schemes in the first stage. In the second stage, we defined the use of a dashboard, the visualizations presented by it, and the relationships between the selected data. In the third stage, the NEXT research group evaluated the visualizations, considering the prototyping stage important for understanding the solution and discarding uncertainties, identifying possible improvements, and more transparent communication between stakeholders. In the fourth stage, we create the low-fidelity prototype with the considerations discussed in the previous step, using the Figma online tool. This prototype was evaluated based on a workshop, using the focus group method, involving computing teachers from technical and higher education. This group was formed by five participants: two D.Sc. Students and three M.Sc. Students, three of the five participants are teachers in CHE, and the others have experiences with the PBL approach. Table II shows the profile of specialists. This meeting was supported by a technology acceptance assessment questionnaire

(Technology Acceptance Model - TAM) sent to participants before the event. The questionnaire consists of 16 questions divided into three blocks: Sociodemographic data; Usability and usefulness of the tool (questions 1 to 6 are related to usefulness, and from 7 to 9 to usability), and; General considerations, requesting subjective comments. We used a value scale based on the Likert scale: 1 - Strongly disagree, 2 - Disagree, 3 - Neutral, 4 - Agree, 5 - Strongly agree. This evaluation will be seen in section V of this article.

TABLE II. SPECIALIST PROFILE

ID	Graduation	Occupation area
P1	Master Student	Computing Education
P2	Doctoral Student	Computing Education
P3	Doctoral Student	Computing Education
P4	Master Student	Computing Education
P5	Master Student	ICT and Educacion

Cycle 3 includes the functional and interactive prototyping of the solution. The first step sought to identify the points for improvement presented in the focus group results and understand usability flaws and changes in visualizations. In the second stage, we developed the functional prototype based on the modified low-fidelity prototype. Third, we seek to validate the update in views and usability flaws in the literature. In the fourth stage, we developed a functional prototype based on the programming languages, technologies, and architectures defined in the first cycle. The evaluation of this prototype is going on, and we planned a new workshop based on a focus group to evaluate it, involving education experts in computing and artificial intelligence. We will use a satisfaction questionnaire composed of objective and subjective questions for this evaluation.

Some threats and limitations could be observed in this work. These limitations are mainly related to the lack of studies in the context of this research regarding educational text processing in the Portuguese language since there are few/no trained models that address the monitoring of professional competencies.

Additionally, in the context of topic modeling, there are still no models as accurate as those found in other languages, for example, English. In the context of software development, there are still not many reports of integration of the technologies used in this study in applications and architectural models. In addition, these applications demand a lot of development time since they are concerned with the algorithm and training the models, defining the data sources, and integrating all these elements to develop the application.

V. A PROPOSAL TO MONITOR STUDENTS' PROFESSIONAL COMPETENCIES

This section describes the design and prototyping of an AI-based subjective feedback processing tool called *SkillSight*, which aims to help teachers monitor student competencies in PBl experiences - considering the three attributes of Knowledge, Skills, and Attitudes - taking into account the planning of your discipline.

As described in Section IV, SkillSight was created using the DSR method, performed in regulatory cycles. These cycles will be detailed in the next subsections.

A. Cycle 1

During the first regulatory cycle, the tool's architecture was defined, we carried out the tests on the technologies with the specified data sources and had the first visualizations. The solution architecture is shown in Fig. 2.

According to Fig.2, SkillSight is composed of three modules: 1) an interface module, responsible for receiving the data source and forwarding the remaining modules, presenting the results in a dashboard; 2) a topic modeling module, which receives subjective feedback, returning the most relevant topics semantically grouped; 3) and a module for Recognition of Named Entities, which classifies some words found in the text, in three categories: Content (related to Knowledge), Soft skills and Attitudes, returning this classification through colored Highlights in the original text.

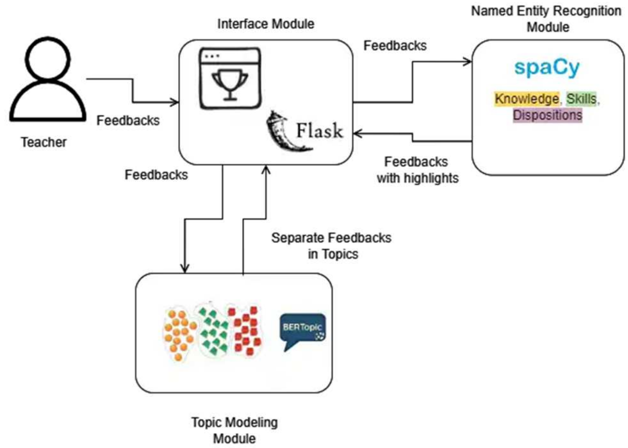

Fig. 2. SkillSight architecture

Regarding the technologies defined for the application, we use a programming language and three technologies. For the development of the tool, we chose the Python language [33], as it has great relevance in the data analysis scenario and the context of text processing and natural language. We use the Flask library for the user interface module- a web development framework written in Python - which aims to build web applications with integration capabilities [34]. Its choice is justified by its expandable yet straightforward programming style, file upload handling, and support for converting specific data outputs.

For the Topic Modeling module, we chose the BERTopic library, considered a topic modeling technique that uses transformers and c-TF-IDF to create dense clusters, allowing for interpretable topics and keeping essential words. The text referring to student feedback is sent in documents grouped according to their semantic relationship and returned as topics and testimonials [31]. The choice of technique and library is justified by the nature of the application, which needs to present information easily interpreted and evaluated by the teacher. Thus, the topics (keywords) and testimonials generated by the library fit this requirement well. Another reason for choosing the library is its support for the initial focus language of this study (Portuguese) and other languages such as English.

We chose the Spacy library for the Named Entity Recognition module, an open-source natural language processing library that uses models based on neural networks and implements natural language processing components such as POS tagging, named entity recognition, and dependency analysis. This library also supports multiple languages such as English, Spanish, French, and Portuguese [36]. The choice of the library is justified due to: support for the Portuguese language and the possibility of training an entity recognizer different from the one already pre-trained in the library; visualizations that can be used to present the data and its application in extracting the information; natural language understanding systems.

In the first regulatory cycle, the first views were tested, one of them in a word cloud format, in which the topics returned by the topic modeling module was presented visually in a cloud format, as can be seen in Fig. 3.

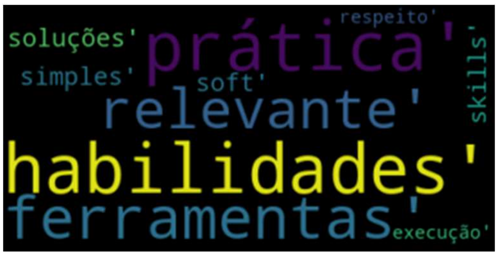

Fig. 3. Visualization in word cloud

B. Cycle 2

In the second regulatory cycle, we developed the low-fidelity prototype and the dashboards that present the results of the processed feedback, as shown in Fig. 4, 5, and 6.

Fig. 4 presents the feedback input screen, in which teachers must send student feedback in CSV format, collected at the end of each learning cycle/module.

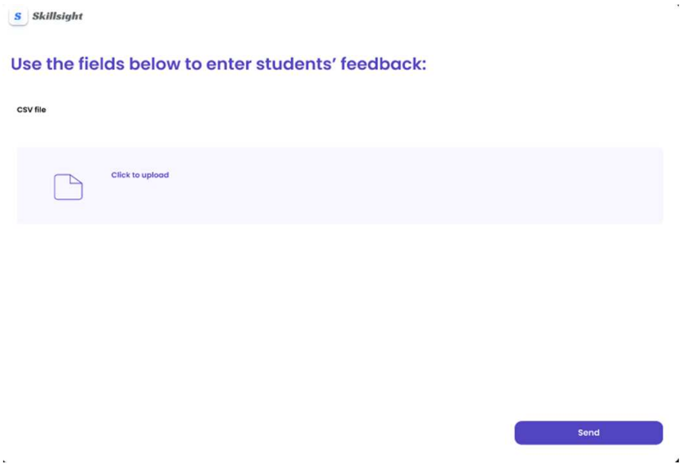

Fig. 4. SkillSight - tela de inserção dos feedback

The application is composed of a tab design, in which each tab represents a different view of the feedback (options A, B, and C). Fig. 5 shows the visualization of feedback through the topic modeling technique, where they are presented in a table in two columns (option A): the left column with the topics in the form of keywords; the right column with the testimonies in plain text, associated with these topics.

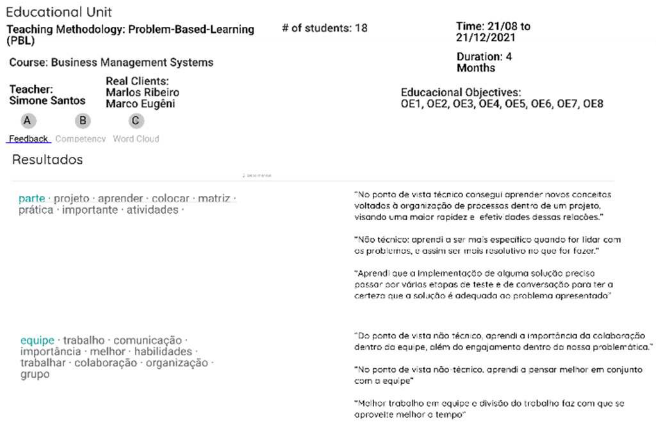

Fig. 5. SkillSight - Topics visualization interface

In addition to the views in table format containing topics and feedback, another visualization is proposed in category format, as shown in Fig. 6 (option B). Through the Named Entities Recognition technique, the application highlights some words throughout the text, using a color highlight for easy understanding, categorized according to each competency attribute: Content (which relates to knowledge), highlighted in blue; Soft Skills (which is related to skills), in pink; and Attitudes, in yellow.

Fig. 6. SkillSight - Competencies visualization interface

Finally, the last visualization shows a word cloud (option C), highlighting the main topics mentioned in the feedback in the general view, as illustrated in Fig. 3.

After completing this prototyping, we held a workshop using the focus group method to evaluate the prototyping with computer education professionals mentioned in Section IV. Fig. 7 shows the results of SkillSight's usefulness and usability assessment.

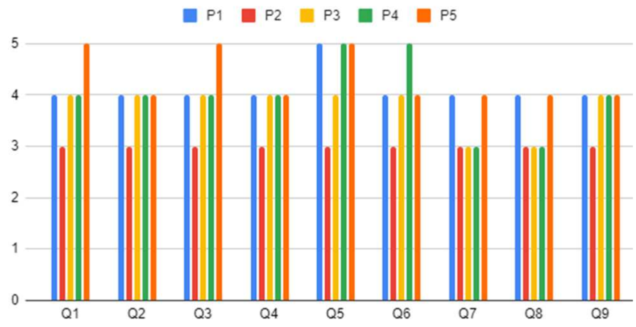

Fig. 7. TAM evaluation of the SkillSight

Table III presents the nine questions of the TAM questionnaire.

TABLE III. TAM QUESTIONNAIRE

ID	Question
1	Using the clustering and summarization tool - SkillSight in my work would allow me to analyze learning outcomes faster.
2	Using the SkillSight tool would improve my performance in analyzing learning outcomes.
3	Using the SkillSight tool in the analysis of learning outcomes would increase my productivity.
4	Using the SkillSight tool would improve my effectiveness in the learning analytics.
5	Using the SkillSight tool would make my job easier.
6	I would think the SkillSight tool useful in my work.
7	Analyzing learning outcomes would be easy for me.
8	I would think it easy to analyze learning outcomes with SkillSight.
9	I would recommend the SkillSight tool to other teachers.
Open	What do you think about the proposed solution?
Open	Do you have any suggestions to improve the proposed solution?

From the TAM questions, we can see that the tool's usefulness (Questions 1 to 6) was accepted by most respondents, with an agreed percentage of approximately 80% and no disagreement. In terms of usability, some participants had a stance of neutrality and acceptance by others. Regarding the tool's recommendation, 80% of the participants indicated SkillSight.

From general considerations (open questions), it is possible to detect several important observations about the tool, such as its insertion in the educational data mining area and possibilities of use. In this sense, participant P1 highlights an important point: "*This tool will help me to be proactive in the face of students' learning difficulties. My opinion regarding the proposed solution is that it has a very significant potential for free text educational data mining activities*." Participant P2 points out the tool as necessary at different times of the learning cycle and for other modes of teaching: *"[...] it would be very interesting to use it in evaluative activities both at the end of the cycle and at its beginning (e.g. Just -in-Time Teaching)*." Participant P3 also highlighted: *"[...] it would greatly improve the form and understanding of our class strategies, especially for a beginning teacher, who still does not have the maturity and perception of the nuances of the teacher/student relationship*".

As points of improvement, changes in the categorization part were highlighted, in a more comprehensive view of the use of the tool in scenarios of collecting feedback per class, pointed out by P1: "*Visualizing the groups by feedbacks in a synthetic and analytical way. Example: Students who said they did not understand anything in a certain class, those who liked it, etc.*"

C. Preliminary Discussions

From the performance of the first evaluations, both the TAM evaluation and the open questions, it was possible to perceive a good acceptance of SkillSight, highlighting the importance of tools of this type for CHE related to some key points: its application in different moments of the teaching and learning process; understanding of nuances in the learning process; insertion of the tool in the context of educational data mining, based on subjective evaluation models. It was also possible to verify the participants' acceptance of the available visualizations. However, some demands for grouping results become evident, such as the visualization of competencies by teams of students.

It is also worth highlighting the technical challenges encountered so far. Working with AI models that need to be trained in natural language. The Natural Language Processing in Portuguese is not as robust as other languages, like English. Concerning the Entity Named Recognition, a NER model to recognize competencies or educational aspects doesn't exist, so it needs to be created and trained. There are few works that process educational texts in Portuguese. Especially those that use Topic Modeling and/or NER.

This study recognizes that the path to the desired solution is just beginning despite early advances. Therefore, we are working on carrying out other functional prototyping activities since it is still necessary for specialists to use the tool to obtain more informed feedback.

VI. CONCLUSIONS

Computing higher education is undergoing a growing movement to shift the traditional paradigm of knowledge-based teaching to competency-based education, using active educational models such as PBL. Along with the changes, there is a need to monitor these competencies to verify their development. The Constructive Alignment Theory represents a way to carry out this follow-up. Despite this, there are still difficulties in its realization, especially when it is done through subjective feedback from students and large classes continuously.

This study proposes an application for processing student feedback, making the competencies perceived by them evident, based on text processing and natural language techniques, called SkillSight. The first cycles defined the application architecture, technologies, and a low-fidelity prototype. The results showed a good acceptance but also indicated some changes in the interface, the need to carry out new interactions, and high-fidelity prototyping.

In future works, we intend to finalize the high-fidelity prototyping, apply both objective and subjective evaluation questionnaires with the specialists and carry out the necessary improvements, ending the third regulatory cycle. We also intend to perform feedback processing tests in other languages, such as English, verifying if there is better accuracy in the results.

ACKNOWLEDGMENT

This work was supported by the N.E.X.T (iNnovative Educational eXperience in Technology) Research Group at the Informatics Center of Federal University of Pernambuco (UFPE, Brazil). The authors would like to thank the teachers and students that participated in this research project.

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