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The Innovative Teachers Training for Chemistry Teaching through Digital Technologies

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Context

- Federal University of Viçosa, Brazil.
- Initial Chemistry Teacher Education.
- it is necessary to offer all students a **Scientific Education** that makes Science a true partner for **other ways of seeing and interpreting the world**, that is, different looks according to different cultures (Lemke, 2006).
- From the development of scientific and technological literacy, important skills can be developed, such as: **critical thinking, problem solving, creativity, innovation, communication, collaboration, making decisions, information technology application, lifelong learning.**
- And these skills can be developed through **technological tools**, as long as teachers **develop dialogic and reflective classes**, with a view to favoring meaningful learning by students.

Reflection-Oriented Process

- During the development of the discipline *Instrumentation for the Chemistry Teaching I* course, of the Degree in Chemistry, which aims training teachers for Basic Education, reflective practice was developed through a **Reflection-Oriented Process**, which allows the student to question and critically reflect on simplistic views of the science teaching and learning process.
- In previous semesters, it was observed that students had **restricted conceptions about practical activities**, as well as the **teaching and learning process.**
- In this context, we sought to understand the students' conceptions / perceptions regarding the planning and carrying out of practical work and the teaching and learning process, **based on activities planned and carried out through digital technologies** by the students themselves.

(Abell & Bryan, 1997)

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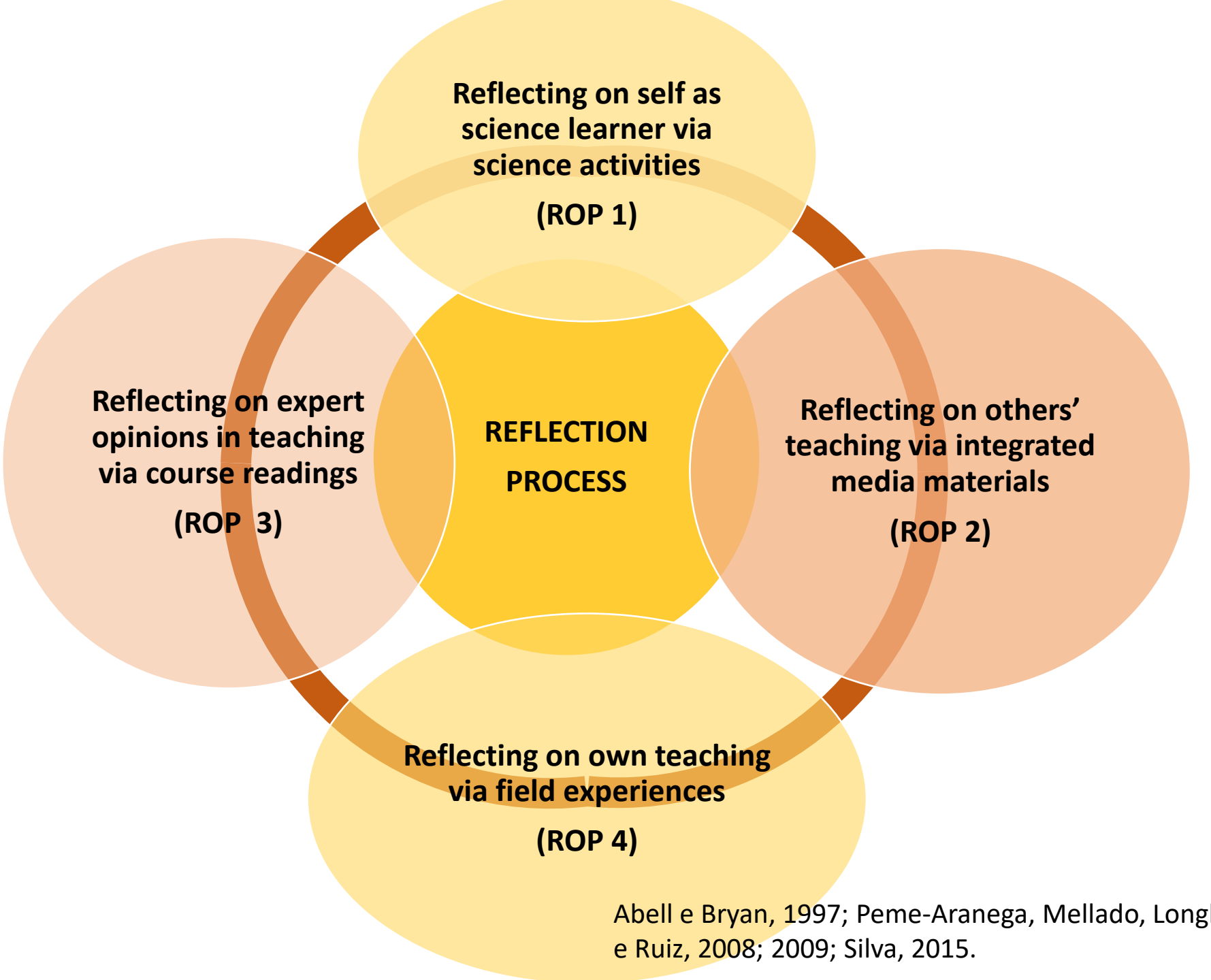
Research Question

How to develop innovative teachers through digital technologies?



Abell e Bryan, 1997; Peme-Aranega, Mellado, Longhi e Ruiz, 2008; 2009; Silva, 2015.

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Methodology

- During the discipline *Instrumentation for Chemistry Teaching I*, twenty-four (24) students participated in various activities that were developed aiming at the formation of innovative teachers, who should know how to plan and conduct their classes with autonomy, knowing how to plan and manage innovative projects, with creativity and self-confidence. In order to develop these and other teaching skills, a Reflection-Oriented Process was carried out, to develop different reflective exercises from four interrelated contexts.
- Research was based on the qualitative paradigm.
- All classes in the year 2020 were developed using digital technologies due to the Covid-19 Pandemic and were recorded on Google Meet, enabling data to be obtained (Amado, 2014; Coutinho, 2014); Data analyses were made by content analysis.

Different activities are carried out the formation of innovative teachers

- Several topics were discussed based on articles by important researchers in the area of Science Education, during the **Reflection-Oriented Process (PRO)** such as:
- “Deformed visions of Science and Technology” by Cachapuz et al. (2005);
- "Why don't students learn the science that is taught to them?" De Pozo and Crespo (2009);
- “The Teaching and Learning of Sciences” by Anna M. P. Carvalho (2011);
- “The manifestation of cognitive skills in experimental investigative activities in high school chemistry” by Suart and Marcondes (2009);
- “The place of affectivity in the Pedagogical Relationship: Contributions to Teacher Education” by Amado et al. (2009);
- “Science Education with STS Orientation” by Vieira, Tenreiro-Vieira and Martins (2011);
- “The Syndrome of Accelerated Thinking” by Cury (2007).

Reflection-Oriented Process

- we reflect on other teaching practices through videos produced by research professors in the area of Science Education, thus enabling several reflections on important aspects for didactic-pedagogical practice, such as:

✓the importance of active participation of students in carrying out activities, which enables the development of interactions between students, important and necessary to favor the understanding of the scientific concepts under study;

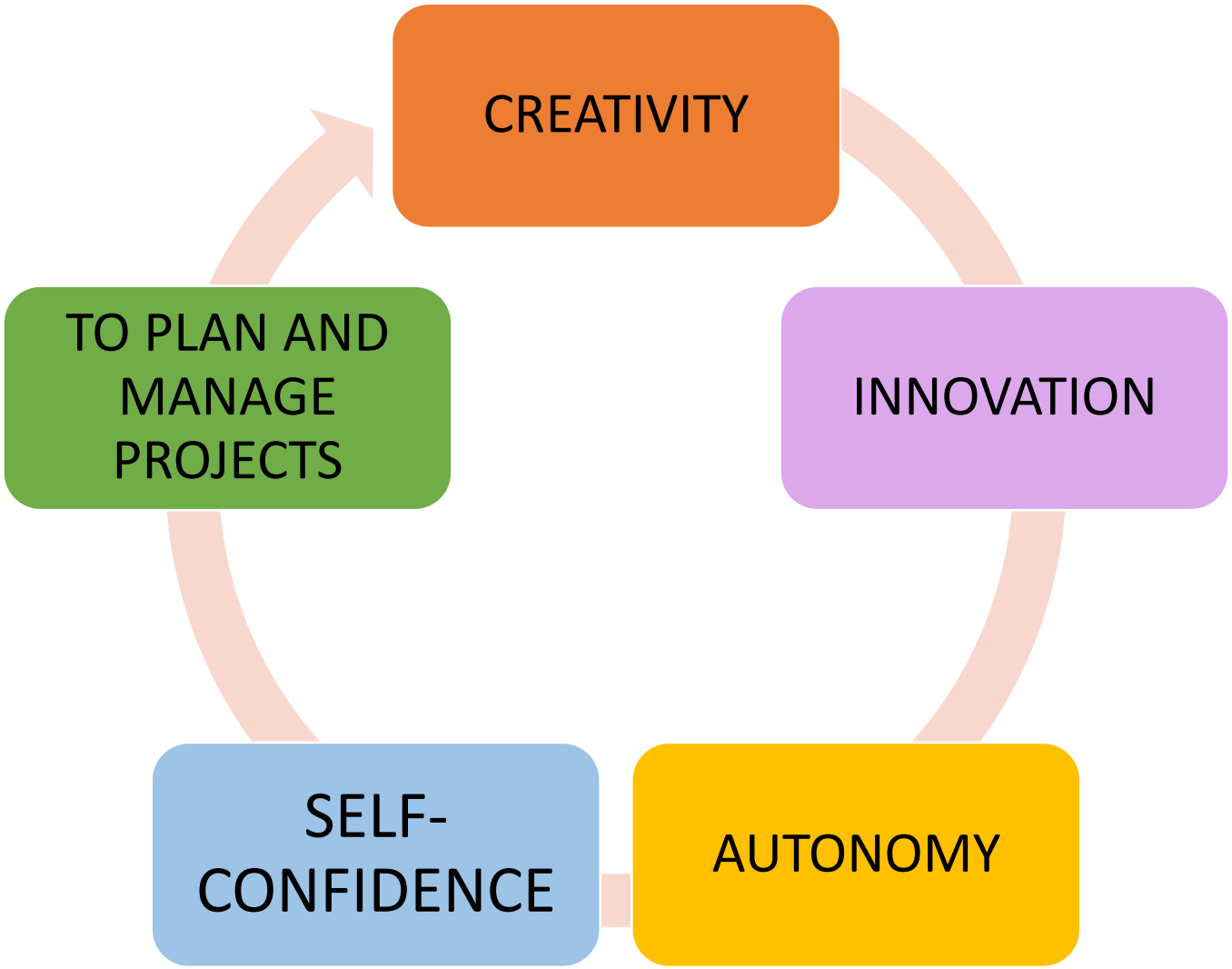
✓the importance of the teacher's mediating role during the performance of activities by asking questions about the subjects studied;

✓in addition to the development of the transition from everyday to scientific language;

✓research teaching **activities planned and carried out through digital technologies**

(Abell & Bryan, 1997)

Teaching skills



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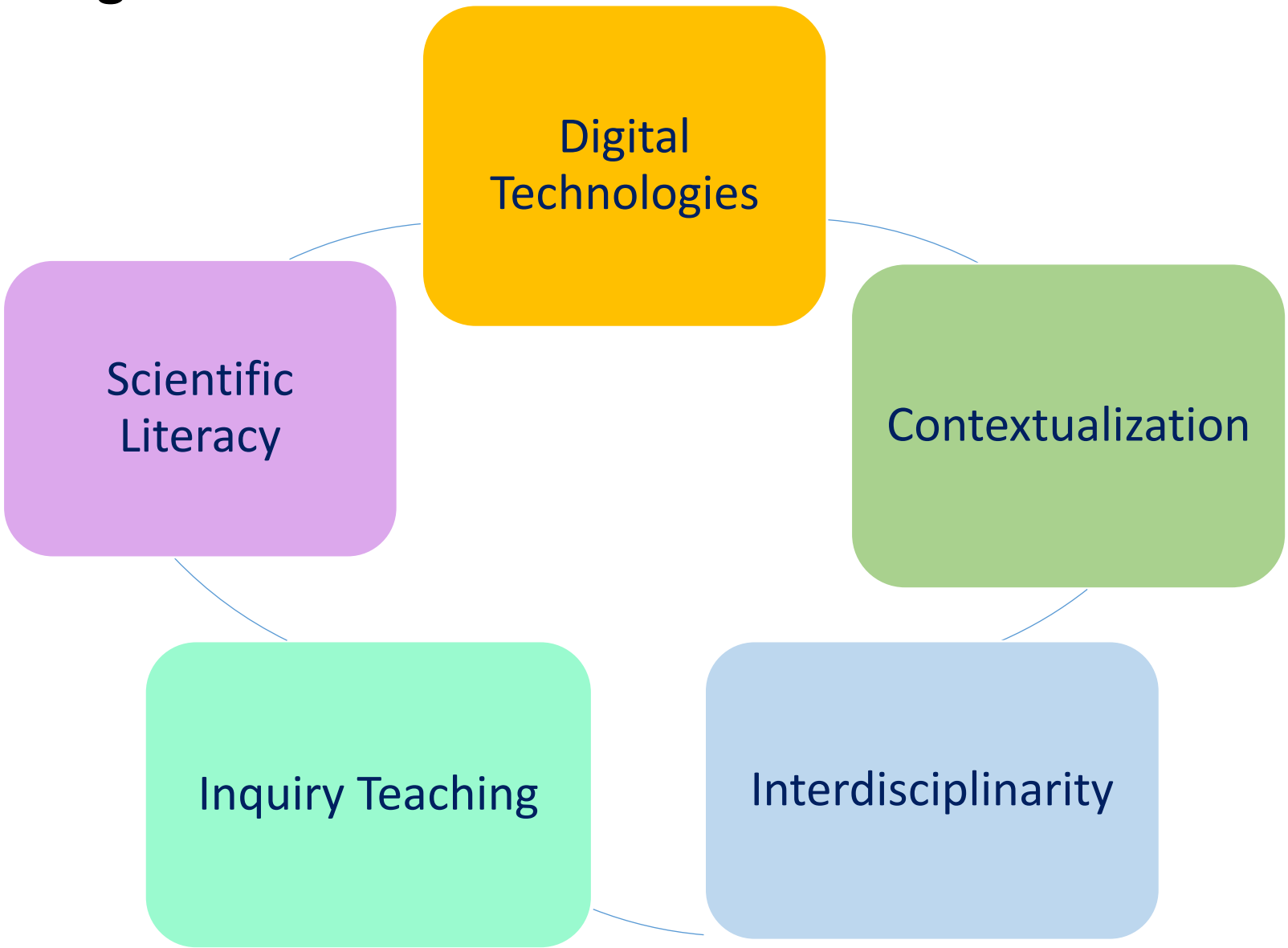
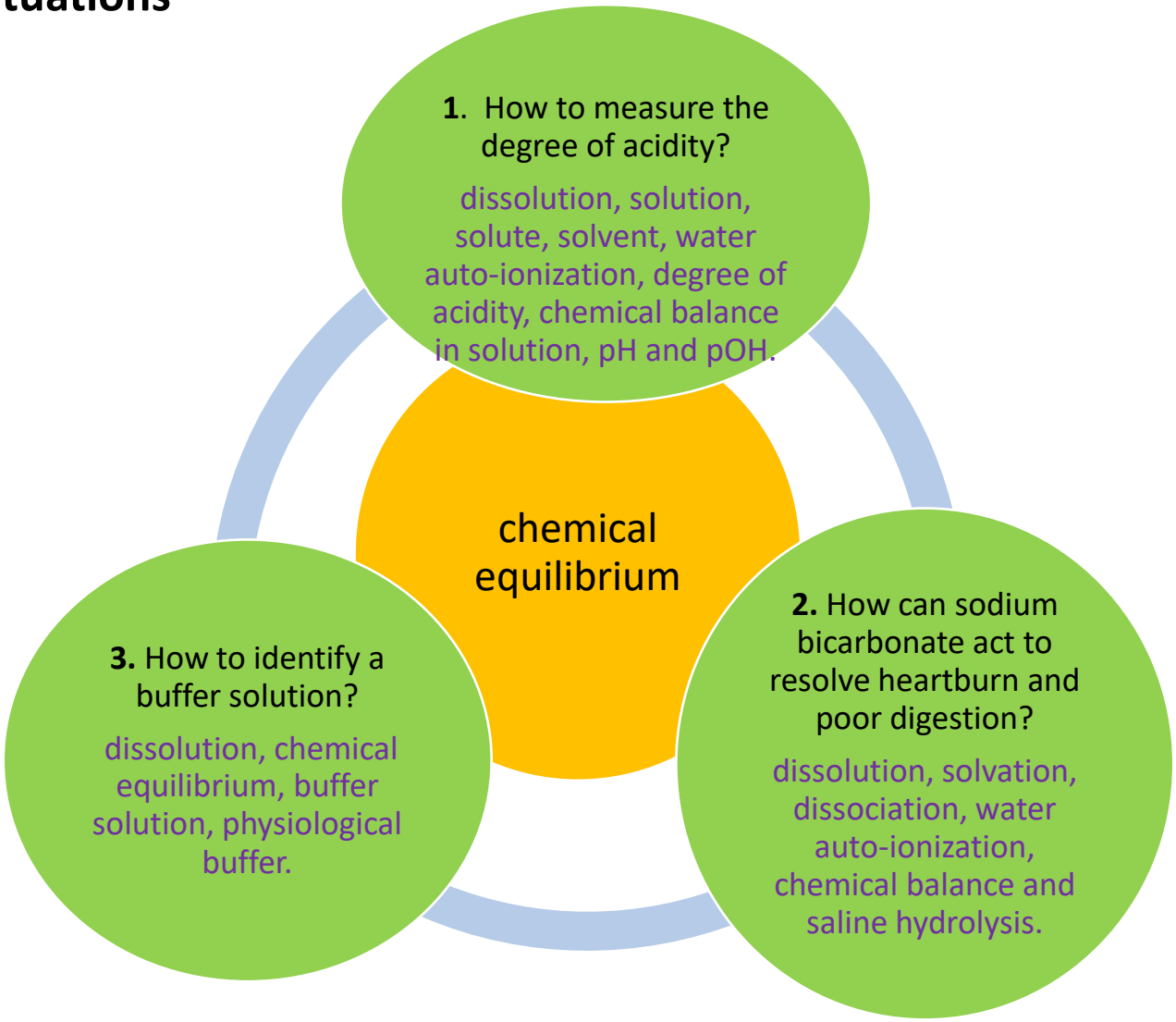
- After the various reflections provided by the researchers' opinions and on other teaching practices based on didactic resources, a new activity was requested by me: **the planning and realization of a practical work, contextualized, interdisciplinary and investigative class, to develop an experiment using digital technologies**.
- Then I organized a **sequence of six practical classes of 90 minutes each**, for six different groups, with four students each group, addressing the chemical concept of chemical equilibrium as a guide for the six classes.
- **I provided a Lesson Plan**, which included**: the topic of the lesson; the problem situation; the justification for the class; the goals; conceptual contents; competencies and skills; didactic resources; the methodology; the evaluation; bibliographic references; attachments.**

DIDACTIC SEQUENCE approaches with **digital technologies**



CHEMISTRY TEACHING THROUGH DIGITAL TECHNOLOGIES

Problem situations



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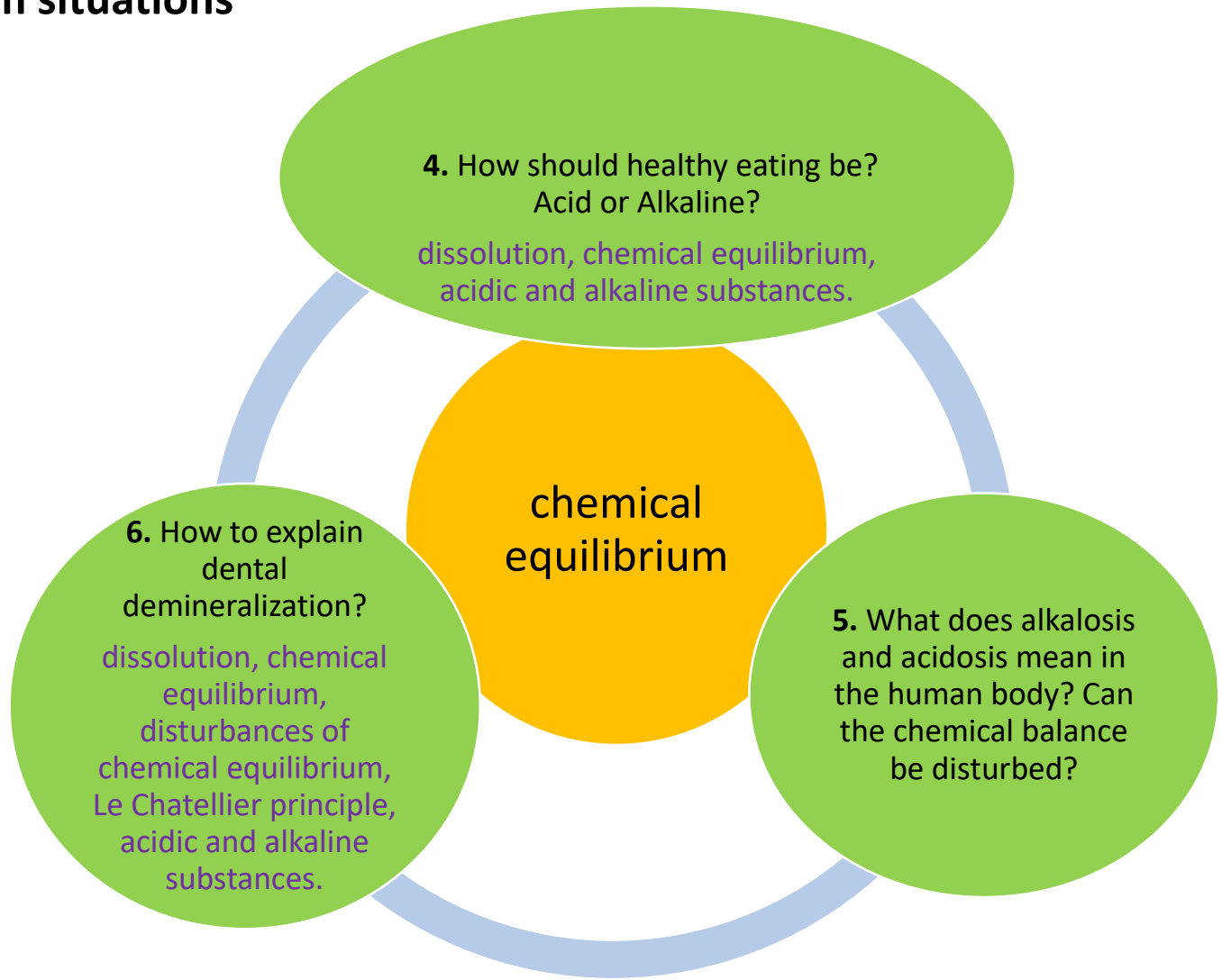

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Class Plan

- In the period of 30 days, **the students prepared the Class Plan** and **developed the class prepared only for the coordinating teacher**, as a **test class**, with a view to discussing all the necessary pedagogical aspects, such as:
- the concepts covered and the teaching strategies used, in order to reflect if what was planned and accomplished was coherent,
- if the class had an investigative approach,
- if it was contextualized and interdisciplinary,
- if it used appropriate digital technologies,
- if it favored the active participation of students, so that they could be protagonists of the process of knowledge construction.

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Findings and discussion

- initially, the first exercise was the elaboration of a drawing about the work of scientists. In this exercise, students were surprised by their views on the nature of science and the work of scientists. The students compared their drawings with the categories developed by Cachapuz et al. (2005) and found distorted views, such as: **empirical-inductivist conception; decontextualized and neutral; problematic and a-historical; individualistic and elitist**.

- It was a very enriching moment for everyone when they realized in their drawings **manifested conceptions that they were not even aware of.** Thus, when they became aware of their distorted conceptions, **they realized how necessary and important it is to have an adequate view of the nature of Science to be a teacher**.

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Findings and discussion

- The realization of the **test classes was a much more enriching reflexive exercise**, as the development of the test classes was extremely important **to become aware of their restricted views of the teaching and learning process**, when giving an **expository class, privileging the transmission of information and neglecting the active student participation**.
- It was really a very complex, therefore, the lesson plan presented more current ideas for the teaching of Chemistry, with a proposal for an investigative, contextualized and interdisciplinary class, using digital technologies.
- **I**n all groups when taking the class, these characteristics were neglected.
- The discussion promoted by me after the test class allowed different reflections by the students and the awareness of the **inconsistency between what was planned and what was accomplished.**

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- **It was necessary for me to reorganize the sequence of activities prepared for the class**, in the sense that the class is really contextualized, interdisciplinary and investigative, developing three pedagogical moments: (i) **the initial problematization,** (ii) **the organization of knowledge and** (iii) **the application of knowledge (DELIZOICOV, 2003).**
- It was also necessary to highlight **the importance of managing class time** and the **teaching strategies used**. After the discussions held, the students accepted the suggestions given by the teacher, showing that the **reflective practice developed** was quite significant and the teacher's argument was effective.
- **They rethought about**: how to develop the initial problematization; the development of scientific language; the introduction to mathematical languages (tables, graphs and equations); pedagogical relationships and affectivity; the development of high-order cognitive skills; and how to promote dialogical interactions during the class to favor the understanding of the concepts covered and the arguments to be developed by the students. Another aspect discussed was the adequacy of digital technology to be used to promote practical work.

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Findings and discussion

- **They became aware that they were developing the class from a traditional approach, in which the teacher privileges the exposure of information, not valuing the initial problematization, neither the prepared contextualization nor the effective participation of the students**.
- The exercise of the **test class was effectively a very enriching and productive reflective practice**, promoting particularly important reflections on the teaching and learning process, as well as on the teacher's posture in the classroom.
- For the analysis of the practical classes, the videos recorded by Google Meet were watched again by me to analyze the consistency between what was planned and discussed during the test class and what was accomplished. Another aspect analyzed was the application of teaching strategies with socio-constructivist principles as it had been studied before planning the class from the articles studied.

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Findings and discussion

- **The students when developing the class revealed that they reorganized the sequence of activities of the class according to the instructions given by the teacher during the test class**, and valued Carvalho's proposal for Science teaching and learning for the planning and organization of the Investigatives Sequences of Teaching (CARVALHO, 2011).
- All groups sought to develop the active student participation; the role of the teacher as a question maker; the creation of an encouraging environment; the teaching from the knowledge that the student brings to the classroom; the problem has to be meaningful to the student; the relationship between Science, Technology and Society and the transition from everyday language to scientific language.
- Only the student-student interactions were not well developed due to the limitation of the digital environment, as the class was held by the remote system (Google-Meet), making interactions between students impossible.

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Digital techonologies to promote learning

- The digital technologies that emerged from the planning and realization of classes were, as requested by me: the virtual laboratories enabled the development of investigative experimental activities: (https://phet.colorado.edu/pt_BR/; https://interactives.ck12.org/simulations/chemistry.html), which made possible the **effective participation of students**; as well as enabled the understanding of chemical concepts by the students.
- videos to promote contextualization and interdisciplinarity of contents (YouTube), enabling the understanding of **relationships established between Science, Technology and Society**; videos produced by the students themselves addressing experiments related to the chemical concepts covered;
- Kahoot **games** (like quizzes) enabling the **participation of students**.

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General Discussion

- After conducting all classes, I promoted a general discussion about the six classes, developing a new reflexive practice so that students could become aware of all the work developed, of the reconstructions made about the teaching and learning process and the use of digital technologies.

- I pointed out the important accomplishment made by them when developing classes with socio-constructivist principles aiming at the development of scientific literacy and privileging the students' learning.

- In addition to pointing out the **important teaching skills** developed by them, necessary for the development of scientific literacy, such as: **ability to provoke argument in the classroom; ability to transform everyday language into scientific language; ability to introduce students to the language of mathematics** (table, graphs, equations).

General Discussion

- At the end of this reflective practice, **many students wanted to express how they felt after experiencing this reflexive process during the course**. Most of them expressed **great satisfaction** saying that they enjoyed very much all the activities performed. They also said that they perceived the reflexive process in an evolutionary way, in which one subject was linked to the next. They even used an analogy: **they felt as if they were climbing a ladder, with each new study a new conquered step**. Likewise, they enjoyed the exercise of planning and conducting practical classes using digital technologies, commenting that **it was a great challenge to prepare classes with the new digital tools for a remote education system**, as well as to face the various difficulties experienced for the preparation of the lessons. Finally, they realized how much they evolved in their views about the teaching and learning process, when they commented that exposing content is not enough to promote teaching.

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Conclusions

- From a **Reflection-Oriented Process**, the pre-service teachers analyzed different didactic and pedagogical aspects about their Inquiry Didactic Sequence, such as: teaching approaches, characteristics of inquiry teaching, development of cognitive abilities and attitudes, as well as scientific concepts.
- Both the teacher training process performed in this discipline *Instrumentation for Chemistry Teaching I* and the didactic sequence planned and developed by the students **were developed through digital technologies**, revealing the great importance of the proper use of technological tools to facilitate the teaching process and learning at different levels of education.

- Thank you so much!!
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Theoretical Framework

Reflection-Oriented Process:

- Abell e Bryan, 1997; Peme-Aranega, Mellado, Longhi e Ruiz, 2008; 2009.

Science Education and Scientific Literacy:

- Carvalho et al., 2014; Galvão et al., 2011; Osborne; Dillon, 2008; Praia; Gil-Pérez; Vilches, 2007; Sasseron, 2008; Cachapuz et al. 2005; Deboer, 2000; Bybee, 1995; Unesco, 1999.

Science Education and Learning:

- Pozo e Crespo, 2009; Carvalho et al. 1998.

Digital Technologies

- Leite, 2019; European Commission, 2020.

Teacher training, Reflexive Practice and Teacher Professional Development:

- García e Porlán, 1997; Freire, 1998; Carvalho e Gil-Pérez, 1993; Carvalho, 2012, 2011, 2007; Alarcão, 2011; Zeichner, 2008; Macedo, 2005; De Pro Brueno, Pérez e Sánchez Blanco, 2005; Silva, 2015).