

State of knowledge in research on socio-scientific issues in chemistry education (2018-2022)

Estado de conhecimento sobre questões sociocientíficas no Ensino de Química (2018-2022)

Estado del conocimiento de las investigaciones sobre cuestiones sociocientíficas en la enseñanza de la química (2018-2022)

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Abstract

Socio-scientific Issues (SQ) address complex topics that require scientific, social, political, environmental and technological knowledge. This article investigated the state of knowledge about QSC in chemistry teaching from 2018 to 2022, using the Brazilian Digital Library of Theses and Dissertations (BDTD). The objective was to understand how QSC are approached in the educational context, providing a comprehensive view of the knowledge produced during the period investigated. The research, of a basic nature and qualitative approach, sought to explore the topic through bibliographic procedures. After applying inclusion and exclusion criteria, it was possible to quantify and analyze the selected theses and dissertations, forming the textual corpus of this study. Therefore, the total of works found were 33 (thirty-three), being 24 (twenty-four) dissertations and 9 (nine) theses that worked on QSC in chemistry teaching. The didactic sequences or teaching sequences through investigation prevailed in the methodologies of the dissertations and the focus of their investigations centered on the students, while in the theses the formation of concepts and arguments of authors such as Toulmin, Walton and Giroux prevailed, with the focus of investigation being the training concepts and the teacher training.

Keywords: Chemistry Education. State of Knowledge. Socio-scientific Issue.

Resumo

Questões Sociocientíficas (QSC) abordam temas complexos que demandam conhecimento científico, social, político, ambiental e tecnológico. Este artigo investigou o estado do conhecimento sobre as QSC no ensino de química de 2018 a 2022, utilizando a Biblioteca Digital Brasileira de Teses e Dissertações (BDTD). O objetivo foi compreender como as QSC são abordadas no contexto educacional, proporcionando uma visão abrangente do conhecimento produzido durante o período investigado. A pesquisa, de natureza básica e abordagem qualitativa, buscou explorar o tema por meio de procedimentos bibliográficos. Após aplicar critérios de inclusão e exclusão, foi possível quantificar e analisar as teses e dissertações selecionadas, formando o corpus textual deste estudo. Logo, o total de trabalhos encontrados foram 33 (trinta e três), sendo 24 (vinte e quatro) dissertações e 9 (nove) teses que trabalhavam QSC no ensino de química. As sequências didáticas ou sequências de ensino por investigação prevaleceram nas metodologias das dissertações e o foco de suas investigações centrou nos alunos, já nas teses prevaleceu as formações de conceitos e de argumentação de autores como Toulmin, Walton e Giroux tendo como foco de investigação a formação de conceitos e a formação de professores.

Palavras-chave: Ensino de Química. Estado do Conhecimento. Questão sociocientífica.

Resumen

Las Cuestiones Sociocientíficas (CS) abordan temas complejos que requieren conocimientos científicos, sociales, políticos, ambientales y tecnológicos. Este artículo investigó el estado del conocimiento sobre QSC en la enseñanza de la química de 2018 a 2022, utilizando la Biblioteca Digital Brasileña de Tesis y Disertaciones (BDTD). El objetivo fue comprender cómo se abordan las QSC en el contexto educativo, brindando una visión integral del conocimiento producido durante el período investigado. La investigación, de carácter básico y enfoque cualitativo, buscó explorar el tema a través de procedimientos bibliográficos. Luego de aplicar criterios de inclusión y exclusión, fue posible cuantificar y analizar las tesis y disertaciones seleccionadas, conformando el corpus textual de este estudio. Por tanto, el total de trabajos encontrados fue 33 (treinta y tres), ser 24 (veinticuatro) disertaciones y 9 (nueve) tesis que trabajaron el QSC

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en la enseñanza de la química. En las metodologías de las disertaciones pre-valecieron las secuencias didácticas o secuencias de enseñanza a través de la investigación y el enfoque de sus investigaciones se centró en los estudiantes, mientras que en las tesis prevaleció la formación de conceptos y argumentos de autores como Toulmin, Walton y Giroux, con el enfoque de investigación siendo los conceptos de formación y la formación docente.

Palabras Clave: Enseñanza de Química. Estado del Conocimiento. Cuestión Sociocientífica.

1. INTRODUCTION

The search to comprehend the things that exist is part of the essence of the human beings. For this reason may be inferred the research is part of this path, in other words, It is possible to turn the unknown more evident and available for everyone. Therefore, the project starts clarifying to the readers the concept and goals of the approach of socio-scientific issues (SSI) in chemistry education. Then, we outlined about the procedures and methods of the research we utilized to get the intended results.

SSI are complex problems, that allow a contextualized approach of interdisciplinary contents, that may be shifted to the scientific education, since the scientific knowledge is fundamental for the understanding and search of solutions for these issues. Besides, the use of the SSI in education promotes the mobilization of values, abilities and attitudes (Nunes-Neto; Conrado, 2018).

Consequently, based on the scientific knowledge the key features of the SSI are: to encompass the formation of opinions in personal or social levels, often published on medias; handle inconclusive informations; deal with local dimension subjects, nationally and globally; involve the cost-benefit analysis in which the risk interacts with the values; engage subjects of sustainable development and reasoning of ethical value (Ratcliffe; Grace, 2003).

According to Reis (2013) the SSI approach is conducive in terms of science learning, as well as the cognitive, social, political moral an ethical development of the individuals involved.

For Conrado (2013) the educational goals linked with the SSI approach on the processes of education and learning are: the learning of disciplinary contents, the development of argumentative skills, the comprehension of epistemological aspects in science, the development of positive attitudes in relation to science and the increased of moral sensitivity.

Teachers when provide discussions around the SSI and support their students to engage in socio-politics actions, show that they recognize the science and technology are human enterprise, complex and dynamic. That way, the SSI approach, allows the critical analysis of the reality, the dialogue and besides that empower the involved ones in the educational process to embrace their social role (Ribeiro, 2021).

Consequently, understanding the importance that the SSI have with a more human education able to contribute in the formation of individuals capable of discussing in a more critical way with the society.

The research is a state of knowledge type according to Santos e Moreira (2020) is essential to deepening the knowledge produced about an object or certain theme, as they

are productions that try to answer that aspects and dimensions are being highlighted and privileged in different places and periods, in which ways and conditions the master dissertations, doctoral theses, publication in scientific journals, congress annals and many other projects are being produced.

Therefore, the present article had the goal to perform a research state of knowledge type about SSI in the chemistry education in 2018 to 2022 on the platform of the Coordination for the Improvement of Higher Education Personnel (CAPES) and on the collection of the Brazilian Digital Library of Theses and Dissertations (BDTD).

2. PATHS FOR THE RESEARCH

The research characterizes as a qualitative approach, of basic nature, with exploratory goals, a bibliographic state of knowledge type. The qualitative approach research doesn't require the use of statistical methods and techniques. The researcher tends to analyze the data inductively and its main focus are the process and its mean (Da Silva; Menezes, 2005).

Consequently, the bibliographic research is generated based on books, periodical publications, printed matter, and material available on the internet. Besides, a good part of exploratory studies can be defined as bibliographic researches (Gil, 1991, 2002).

According to the authors Morosini and Fernandes (2014) the goals of the knowledge state is to know, systematize and analyse the production of the scientific field of a topic; to elaborate text production to create dissertations or theses; subsidize dissertations and theses, delimiting a specific topic contributes with the choices of the methodological paths of respective projects. They also describe that the state knowledge goes beyond the categorization, since it's necessary to make inferences about the information that has been analyzed.

The searches for the text corpus were realized on the CAPES platform, in the BDTD's collection. To refine the research the timeline chosen was 5 years (2018 to 2022). For the selection criteria for the descriptors, the studies made were about the following topics: SSI, controversial topics, chemistry education and issues related to science, technology, society and environment (CTSA).

Therefore, the texts included were on the chemistry field and dealt with the SSI, CTSA, CTS, logical arguments and high school chemistry topics. The dissertations and theses that didn't have those pieces of information were excluded.

The articles were selected through skimming the text. A systematic reading was done on the selected dissertations and theses to understand the main subject of each text, the original goal of each thesis and dissertation, the kind of research, the main collection data tools, organization and analysis. Subsequently to indicate the main results obtained. Finally, a word cloud was created with the results of the selected theses and dissertations to analyse the similarity between them.

462 (four hundred and sixty-two) theses and dissertations. After analyzing each title, it was observed that several projects repeated themselves.

Consequently, to facilitate the data analysis was made a file organization, excluding the theses and dissertations that repeated themselves, involving a total of 215 (two hundred and fifteen) theses and dissertations.

The second stage of this research counted with a skimming text reading of the 215 abstracts of the theses and dissertations found, applying inclusion and exclusion criteria through skimming text was possible to reach the numbers presented on the Chart 1 below.

Chart 1 - Total of Theses and Dissertations

	2018	2019	2020	2021	2022	Total
Dissertations	3	10	6	5	0	24
Thesis	3	4	2	0	0	9
Grand total	6	14	8	5	0	33

Source: Research data (2023).

On 2022 there were no socio-scientific issue (SSI) related subjects on the chemistry education. Therefore, was noticed that from 2018 there was an increasing of researches involving socio-scientific issues, its peak was in 2019 and the decreasing was on the same year of 2019 aiming to zero according with the data presented on Chart 1.

With the organization of the Chart 2 was possible to observe that during five years, or from 2018 to 2021 the themes related to SSI and other subjects related to this topic were 33 (thirty-three) total between theses and dissertations. The year that had the most projects realized on the chemistry area about the main selected themes on this article was on 2019, with 10 (ten) dissertations and 4 (four) theses. On 2022 there were no published projects with this topic on the chemistry area.

With the skimming text reading of the abstracts, the keywords of each thesis and dissertation, was possible to create and present in a systematic way some information that are relevant for the research, like: Title; Author; Level; Year of published on the CAPES platform in the BDTD's collection; Keywords or subject; Goals; The kind of research and some important information that would help to comprehend the kind of research of the thesis or dissertation; how was the collection and analysis of data.

3. RESULTS AND DISCUSSION

The result of the selection and the organization of the analysis of data, like title, author, keywords, goal, kind of research, collections of data among others are disposed on Chart 2 and Chart 3.

Chart 2 - Systematic reading / Dissertations

Nº	Title/ Author/ Year	Keywords/ Subject	Goals	Kind of research/ others	Collection of data/ Technique/ Analysis of data
1	Didactic sequence about the quality of water: production conditions and the use for the professional education in chemistry. Anjos, Maíra Viterbo Oliveira Dos. 2018	Professional education; CTS approach; Quality of water; Teaching in analytical chemistry; Teaching in environmental chemistry.	Elaborate a didactic sequence about the professional education of the mid level in chemistry and reflect on its application in class.	Descriptive / Case study.	texts, seminars and hands-on activities, as well as observations and notes realized by the researcher during class. Application and evaluation of the didactic sequence. The monitoring was made from the analysis production of the students during the development of the activities and the observations realized by the researcher.
2	Perspective of the science, technology and society approach and their relation with critical thinking skills. Santiago, Ortência da Paz. 2018	Science, technology and society approach; Critical thinking skills; Sequence of teaching-learning.	Investigate which critical thinking skills are used by the students of basic education in contact with didactic materials guided by the CTS approach.	Descriptive research- interpretative; Qualitative research.	The data collection was realized through audiovisual tools and written records during the application of the Sequence of teaching-learning (SEA) that deals with chemistry concepts, like: thermo-chemistry and electro-chemistry
3	The complex thinking in practice of a chemistry teacher: proposes, analysis and reflections in high school classes of a public school. Santos, Josiane Azevedo dos. 2018a	Didactic sequence; Complexity theory; Science teaching; CTSA.	Investigate the possible contribution of the complexity theory for the practice of the chemistry teacher.	Research of qualitative approach, applied research nature, descriptive goal research and participant observation procedure.	Application of a didactic sequence in 4 high school classes at Walter Orlandini State School located in São Gonçalo city, Rio de Janeiro
4	Craft production of curdle cheese: a social-scientific theme for the Elementary school in chemistry teaching. Batista, Maria Elidiana Onofre Costa Lira. 2019	Teacher training; Difficulties on teaching-learning; Chemistry teaching.	diagnose what subject in chemistry teaching the students struggle more, and based on that, plan and apply educational activities that embody the SSI with focus on the approach of related themes of the daily chemistry classes of thew students at the Elementary school.	Qualitative approach but the research goal is descriptive and exploratory	Surveys; open and semi-structured questions; applied for students.

5	The use of stories on the approach of Socio-scientific issues in the teaching of inorganic functions: what are the contributions and limitations for the scientific and technological literacy of students? Bezerra Júnior, Jerônimo Costa. 2019	Teaching in chemistry; Inorganic function; Scientific literacy; Technological literacy.	the goal is to analyze the contributions and limitations of the use of stories on the SSI approach in the inorganic functions for the ACT of students.	Qualitative research for a case study.	Place of research: State Public School with the 2nd-year High School students. Tools for the data collection: surveys, video recording and stories produced by the students collectively. Analyzed by analytic category.
6	Socio-scientific issues on the elaboration of a discursive didactic approach on chemistry classes in college. Rodrigues, Jéssyca Brena Soares. 2019	Argumentation; SSI; Investigative cases; Scientific literacy.	Analyze a discursive approach in the chemistry college that stimulates the appropriation of the science nature and the development of the argumentation through investigative cases that explore the SSI.	Qualitative Approach/ social critique with theoretical perspective.	Graduation students in Chemistry / analyzes of investigative cases/ video recording/ analyzes of the content of the author Bardin/ identify and qualify the arguments through Toulmin's pattern.
7	Proposal of chemistry teaching with a CTS approach aiming at a discussion of a local issue. Kraushaar, Alexandra 2019	Chemistry - Studying and teaching; Science - Social aspects; Technology - Social aspects; Problem-based learning.	Contribute for the construction of the teaching in Chemistry, investigating the interest of the students in a CTS approach aiming at the discussion of a social question in the community.	Qualitative approach with investigative nature. Research action.	The data collection happened through surveys, participant observation, notes on field diaries, activities developed by students, photographs and recordings.
8	Reading of the "Trinity" comics for Chemistry graduates: argumentation and moral sensitivity exercises through socio-scientific issues. Silva, Guilherme Balestiero Da. 2019	Argumentation; teacher training; Comic books; Moral reasoning; Moral sensitivity.	promote, exercise and analyze the argumentation and moral sensitivity of Chemistry graduates before the SSI through the reading practice of comic books.	Qualitative approach with case study nature.	Toulmin's Argumentation Pattern (TAP) and then the based the analyzes on the Components Table Model which allowed the investigation of the moral sensitivity of learners. Reading and analyzing comic books. Workshop.

9	The argumentation as a tool for the construction of a meaningful critical learning on the chemistry education. Lima, Rayssa Suanane de Araújo. 2019	Teaching-learning; Chemistry education; Argumentative Speech.	Evaluate how the argumentation can facilitate the promotion of a meaningful critical learning on the Chemistry education.	Qualitative research	Subjects: 2nd-year high school students. Place: chemistry lab at high school. Data collection: negotiated lecture; critical discussion; preparation of conceptual maps. Data analysis: the study of the argumentative-discursive according to the proposal of Leitão (2007) the argumentative operators proposed by Koch (2000) and the discursive markers by Risso et al. (2006)
10	Integration between the project-based learning and the Chemistry education: a proposal for the construction of the environmental awareness. Liecheski, Adriane. 2019	High School; Chemistry; Active Methodology.	Investigar a contribuição do método Aprendizagem Baseada em Projetos (ABP) na construção do Conhecimento Químico (CQ), bem como na formação da Consciência Ambiental (CA) quando os estudantes são envolvidos em um problema real.	A pesquisa é Abordagem de natureza qualitativa, tendo como metodologia a pesquisa-ação	Envolveu 10 sujeitos. Os dados foram coletados por meio da aplicação de questionários com questões abertas e fechadas, além do uso de questões do tipo Escala Likert. Os dados foram tabulados e analisados à luz da Análise de Conteúdo.
11	Simulation game paper as a stimulating strategy of the capabilities of the critical thinking. Barreto, Joedna Vieira. 2019	Didactic Material; Educational game; and Chemistry Education.	The goal was to investigate the possible capabilities of the critical thinking engaged on students that went through the simulation game paper.	Is a qualitative nature research with investigative study case character.	The data collection was made through video recordings and surveys. The didactic material approach happened on a 2nd-year high school class of a Public School in Sergipe State, 30 students took part in it. The data handling was obtained through the Content Analysis according to Bardin.
12	Analysis of the learning development on the conceptual dimensions, procedural and attitudinal in a didactic sequence about the use of agrochemicals reasoned on the analog modeling. Lima, Adriana Moreira. 2019	SSI; Analog Modeling; Agrochemicals; Conceptual, procedural and attitudinal learning.	investigate the learning of the students on the conceptual, procedural and attitudinal dimensions when they are involved on the SSI discussion on the use of agrochemicals as an alternative to control the disease transmission by the Aedes Aegypti mosquito in a didactic sequence based on the analog modeling.	The research has qualitative character.	Development and application of a didactic sequence. Interviews; Place: State School of Itabirito town - Minas Gerais state.

13	Chemical equilibrium on a coastal context: a proposal of didactic unit. Barbosa, Thuanany Karoline de França. 2019	Was not presented	The purpose was to build, apply and evaluate the development of a Didactic Unit to address the chemical equilibrium matter with high school students of a state school on the town of Macau, in Rio Grande do Norte state.	Qualitative Approach	Application of a didactic unit; Application of surveys. Research developed in a 2nd-year high school class of the State School of Macau/RN.
14	Argumentation in a investigative teaching sequence involving forensic chemistry. Santos, Fernanda dos 2020b.	Investigative teaching sequence; Argumentation; Epistemic practice; forensic chemistry.	The current study had the goal to analyze the development of a investigative teaching sequence, structured around a forensic chemistry theme, checking the argumentation space that was generated and other epistemic practices, on the context of the basic education of teachers.	Qualitative approach nature. With case study	Application of a investigative teaching sequence; application of video recordings. The analysis of the structure of express arguments during the discussions and the written texts, it was used as an analytic tool with Toulmin's Argumentation Pattern (TAP). For the analysis of the epistemic practices, was used a category system proposed by Jiménez-Aleixandre et al. (2008), adapted and synthesised by Silva (2015)
15	The teaching about pesticides and GM foods on the Science, Technology and Society (CTS) approach based on the modified models of Lakatos. Roskosz, Karine Ariele 2020.	Science - Social aspects; Technology - Social aspects; agricultural chemicals; GM foods.	Analyze the contribution of a didactic sequence developed through the "modified models of Lakatos" on the Science, Technology and Society approach (CTS) on the perceptions of students about the pesticides and GM foods.	qualitative and interpretative nature with participant observation.	23 students, from the last year of high school,
16	Thematic workshops as practice to build the scientific knowledge on the chemistry teaching: The search of a meaningful learning and for the intellectual development of students. Romero, Thaís Lopes 2020.	Fuels; Thematic Workshops; Chemistry Education; Learning of concepts.	Contribute for the comprehension of the teaching-learning process, having the contextualization and the investigative experimentation, through the application of Thematic Workshops with focus on the science, technology, society and environment (CTSA), pedagogical proposals capable of promoting scientific training for students.	Research with qualitative and interpretative nature with participative observation.	The data collection was made on two public state schools of São Paulo. Students from the last year of High School.

17	<p>Green chemistry experiments on the CTS approach at high school: tool to build up knowledge and promote the sustainable development.</p> <p>Souza, Carla Cristina Onorio De. 2020</p>	<p>Green chemistry; Chemistry Education; CTS approach; Experiments.</p>	<p>Develop the critic capacity of students in relation to the environment and the sustainable development, using a teaching proposal of a CTS approach about the assumptions of the Green Chemistry.</p>	<p>Research of Qualitative Nature</p>	<p>Place: State School of Paiçandu in Paiçandu town in Paraná. The subjects are students between 16 to 18 years old. Discursive Textual Analysis</p>
18	<p>Proposal and analysis of a investigative didactic sequence with focus on the study of chemistry and society issues related to alcoholic beverages.</p> <p>Matias, Erivelton Felix. 2020</p>	<p>Investigative Didactic Sequence; Chemistry Education; Socio-scientific Approach; Contextualization. Alcoholic beverages.</p>	<p>Elaborate and analyze the Investigative Didactic Sequence (SDI) about the study of chemistry and society related to alcoholic beverages, that was applied to a group of students of the last year of high school from a public school.</p>	<p>Qualitative Approach</p>	<p>Place: State School of Porto Firme (MG). The data collection was led through the analysis of the transcriptions of the voice recorded classes, of the answers to the questions presented on the students written material, besides the observations made by the teacher after the classes. Through the analysis of the content proposal of Bardin.</p>
19	<p>The use of blogs to promote the argumentation at the high-school chemistry classes.</p> <p>Dias, Fabiane Elidia. 2020</p>	<p>Technology; on education; argumentation; blogs; SSI.</p>	<p>development and stimulus on the argumentative practice at the high-school chemistry classes, through blogs.</p>	<p>Qualitative study, based on the assumptions of the study case method.</p>	<p>Surveys. Four blogs were made about the use of pesticides thematic. Argument analysis according to the Toulmin's model. Argument analysis according to de Sá model (2010).</p>
20	<p>Who and What to trust? : working knowledge analysis nature of chemistry graduates.</p> <p>Oliveira, Jordana Alves De. 2021</p>	<p>Science and Technology; Degree; Teachers formation.</p>	<p>Investigate how Chemistry graduates use their nature of science knowledge to analyze statements related to a controversy about low carbohydrates and low fat diets and how their knowledge associate with their positions on the resolution of a socio-scientific issue about the animal meat consumption.</p>	<p>Qualitative approach.</p>	<p>Didactic sequence application. The Whole Science proposal from Douglas Allchin (2011 and 2017) for the education and analysis of the comprehensions of the graduates about nature of science. Analyzed clipping of classes of a didactic sequence using the theoretical reference of Allchin.</p>

21	The development of comprehensions about socio-scientific issues approach in teaching by future chemistry teachers. Silveira, Bárbara Dias 2021	Teachers training; Educational approach on SSI; Chemistry Education; Reflections.	This project has the goal to investigate the development of the comprehensions by future chemistry teachers about the SSI approach on the Science teaching during their degree.	Theoretical-methodological approach on the qualitative research in education.	video and voice recordings and the didactic sequence by the future teachers methodology of textual discursive analysis.
22	Interferences of conflicts between science and religiosity on the Chemistry education. Leite, Robert Ramos 2021	Conflict between science and religiosity; Chemistry Education; Teaching doesn't interfere.	Analyze how the context of the conflict between the science and religiosity happens on the Chemistry Education, that are consequences of daily basis situations in classes.	Qualitative approach / study case.	Interviews/ Surveys The research was realized on high school and college students. Data analysis proposed by Bardin (1977), known as the content analysis
23	Aspects and socio-scientific issues approach on the didactic chemistry books approved in PNLD/2018. Costa, Monara Jane dos Santos 2021	SSI; Chemistry Education; Didactic books.	Comprehend the presence of the SSI aspects on the didactic Chemistry books approved in PNLD/2018	Qualitative approach/ Exploratory goals. Research made on didactic books	Content analysis according to Bardin (2011). It was used as criteria the characteristics pointed out by Santos, Almeida and Silva (2018) to identify the SSI on the analyzed texts. I was also used the Iramuteq software as a tool to analyze the actual approximations between the identified SSI, using the similarity analysis tool.
24	Analysis of a socio-scientific issue by chemistry graduates looking for the development of ethical and moral aspects on the dilemma of the animal meat consumption. Vargas, Isabela Breder 2021	Sociology of knowledge; Teacher-training; Ethic - studying and teaching; Chemistry - students.	Characterize how the Chemistry graduates propose, interact, evaluate and legitimize the knowledge on the resolution of a SSI, and observe and comprehend the conceptions over the ethical and moral ontology that affect the position on the SSI. This research characterizes as qualitative.	Qualitative research.	Voice and video recordings of the development of a didactic sequence in the class of Chemistry Education Practice III.

Fonte: Research Data (2023).

On the essays as well as on the projects developed with a total number of 24 (twenty-four) analyzed, 18 (eighteen) were targeted for the basic education and the content and the approaches developed, had 2 dissertations with the same subject, like Investigative Didactic Sequence and the Elaboration and analysis of Didactic Sequence. The other essays were about: Analysis of Didactic Book; Teacher Formation; CTS Approach; Scientific Literacy; Use of Blogs; Argumentative Speech; Conflicts between Science and Religion; Active Methodology; Concept Learning; Educational Game; Critical thinking Capacity; Analysis of the Learning Development; Complexity Theory; Sustainable Development and Application of a Didactic

Unit. The other 6 (six) essays were directed for the higher education and five of them were about teacher formation.

Chart 3 - Synthesised Reading / Theses

Nº	Título/ Autor/ Ano	Palavras Chaves/ Assunto	Objetivos	Tipo de pesquisa/ outros	Técnica/
1	Concept formation of thermo-chemistry related to Science, Technology, Society and Environment (CTSA) and socio-scientific issues (SSI): contribution for the Theory of the Historic-Cultural activity. Felicio, Beatriz Vivian Schneider. 2018	Education in Science; Chemistry Education; Formation of concepts; Activity Theory; Historic-Cultural Theory.	Analyze the formation process of the thermo-chemistry concepts according to the Historic-Cultural context of students mediated with a CTSA and SSI relation.	Bibliographic research with the approach of Historic-Cultural studies.	Applied on a social project of Education. Video recording of the application of activities sequence;
2	Socio-scientific issues approach: looking for the relation of the different kinds of thinking and contexts on the drug and self-medication study in chemistry education. Bezerra, Bruna Herculano da Silva. 2018	Chemistry Education; Drugs; Self-medication.	Analyze the SSI approach in the chemistry education and the relations between the daily knowledge, scientific and contexts knowledge, from epistemological, ontological and axiological commitments involved on the speeches made in class.	Qualitative approach and descriptive-interpretative character with inductive focus.	9 (nine) took part into the thesis at the State School of Serra Talhada - PE teachers and students from the public education of Serra Talhada-PE; Surveys application. Pedagogical meetings and planning of didactic sequence. Data analysis: Social semiotic, thematic diagram.

3	<p>A study about the reconfiguration of the orientation to write argumentative texts in Chemistry.</p> <p>Araújo, Marcelo Siqueira de. 2018</p>	<p>Galperin; Orientation; Argumentative texts in Chemistry.</p>	<p>General goal is the investigation of the influence of the formative experience on the orientation of Chemistry graduates for the writing of argumentative texts in Chemistry classes.</p>	<p>Qualitative research with exploratory moments; Experiments.</p>	<p>Data collection: (a) pedagogical test; (b) survey; (c) observation and (d) record notebook. The participants were Chemistry graduates from the Federal University of Rio Grande do Norte, Natal campus. Learning based on the Theory of the Planned Formation of Actions and Concepts.</p>
4	<p>Learning process of future chemistry teachers as intellectual transformers: contribution of the life-cycle evaluation as the socio-scientific thematic.</p> <p>Pereira, Ademir de Souza. 2019</p>	<p>Chemistry - Teaching and Learning; Análise do ciclo de vida; Life-cycle analysis; Teachers training; Teacher Formation.</p>	<p>The main goal was to investigate the contribution of the learning process of future chemistry teachers as intellectual transformers on the development and execution of a didactic sequence in chemistry classes of public school, based on four theoretic fields previously experienced by them.</p>	<p>The research has qualitative character.</p>	<p>Using the Giroux theory as base, the content analyses was realized with graduates that took part in activities like seminars, focal orientations, elaboration of didactic sequence and the basic education regency. The graduates reports, the field diaries and voice recordings were analyzed to stablish relationship between the graduates actions and the previously categories.</p>

<p>5</p>	<p>The scientific literacy on the basic education of science teachers: analysis of a curricular unit planned in this perspective. Aragão, Susan Bruna Carneiro. 2019</p>	<p>Scientific Literacy; Initial education for teachers; Science Teaching; Chemistry Education.</p>	<p>The goals of the research was to investigate the conceptions of graduates throughout the scientific literacy and verify how the proposed activities and the actions of the trainer contributed for the reflections of graduates about the scientific literacy and its foundations.</p>	<p>I wasn't expressed. But it's close to a qualitative research.</p>	<p>4 graduates from the evening and nocturnal course and a trained science teacher. The data collection was made through applied activities by the teacher, graduates field diaries, semi-structured interviews with the teacher, survey and final lesson plan. For the analysis was used the levels of Scientific literacy of Bybee that creates elaborated levels of comprehension for each approach</p>
<p>6</p>	<p>Investigative experimentation in chemistry at high school and its potentialities for the argumentation exercises aimed to students. Leal, Rodrigo Rozado. 2019</p>	<p>Investigative experimentation; Argumentation; High School; Chemistry Education.</p>	<p>Use the investigative experimental teaching methodology in the chemistry lab with high-school students verifying the contributions of this approach and promoting argumentative ability exercises and its contribution of the chemistry education centered to students.</p>	<p>Qualitative methodology based on the Moreira (2003) and Rosa (2013) perspectives. Research action.</p>	<p>The application with 20 investigative activities containing several chemistry experiments. Place of application: Chemistry Lab from the polytechnic school in the Federal University of Santa Maria. Research subjects: A chemistry teacher and 152 students from high school between 14 to 17 years old. The speeches were analyzed according to the Toulmin's argumentation pattern.</p>

7	Socio-scientific teaching in Chemistry degree: Speech, experience and Possibilities. Moura, Francisco Marcôncio Targino de. 2019	Chemistry Degree; Teachers training; Curriculum; Socio-scientific Training.	The general goal was to investigate the constituent elements with a socio-scientific perspective on the formation of Chemistry teachers degree, looking to identify an integration and organization of this degree with knowledge and practices in teaching education.	It was a qualitative research, where the chosen method was the Group of Subjects Speech (DSC)	The data research was collected in documents, interviews and discursive testimonies respecting the social field actors engaged on the research since the group was immersed in their territory.
8	Application and elaboration of a tool for the open dialog in class: a study in the educational activities reasoned on the daily, scientific and socio-scientific context modeling. Martins, Marina Rodrigues. 2020	Argumentation. Dialog Theory; Investigative Science Teaching; Education reasoned in modeling; Chemistry Education; High School.	The students' argumentation was investigated over education reasoned in modeling on daily, scientific and socio-scientific contexts through a new tool reasoned in the dialog theory aspects.	Qualitative research	The data collection involved voice and video recordings of all the classes, participant observation of the researcher, field notes and artifacts harvesting. For the data analysis a new analytic tool was used. Reasoned on the ideas of Walton (2006).
9	Environmental problems caused by pesticides: the problem-solving methodology and the scientific investigation on the basic education. Ribeiro, Daniel das Chagas de Azevedo. 2020	Problem solving; Pesticides; interdisciplinary; The critical environmental education; Learning typologies; Autonomy.	The general goal was to evaluate the contribution forms of the applied pedagogical sequence based on the problem-solving for the development of students from the basic education, the autonomy and the conceptual knowledge, procedural and attitudinal related to the risks that the pesticides can cause.	Exploratory and Qualitative approach.	The data research was made through surveys, field diaries, voice recordings and written productions of the students to later be qualitatively analyzed through the Content Analysis.

Fonte: Research data (2023).

From the 9 selected theses 5 of them had their focus developed to the basic education and 4 of them focused their development on higher education texts. And just one subject repeated the ones about the teacher training. The other projects had the following subjects: The formation of concepts; The SSI approach analysis on the chemistry education;

Scientific Literacy; Argumentative written texts; Investigative experimentation; Teachers Training; Dialog theory and the Problem-solving Methodology.

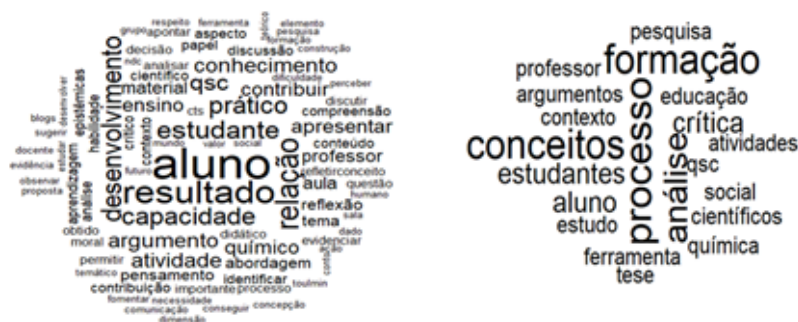
And the results are related with what Nunes-Neto and Conrado (2018) pointed when they mentioned the SSI are complex problems that allow a contextualized approach of interdisciplinary contents that can be relocated to the scientific education since the scientific knowledge is fundamental for the comprehension and search of solutions for these problems. Besides they promote the mobilization of values, abilities and attitudes.

The qualitative approach prevailed on the researches not only on the essays but also on the theses. There was no prevalence on the essays in relation to the data analysis. The main data analysis noted on the research were: Content Analysis according to Bardin; Software use for the Similarity Analysis; Argument qualification by the Toulmin's Pattern; Discursive textual analysis; Analysis through Analytic Categories.

On the theses field the analysis results used in each project were: Content Analysis; a new analytic tool reasoned on the ideas of Walton (2006); Speech Analysis according to the Toulmin's Argumentation Pattern; Levels of Scientific literacy of Bybee and form Levels of Comprehension to each Approach; Giroux Theory; Theory of the Planned Formation of Actions and Concepts; Social Semiotic and Thematic Diagram.

The acquisition of word clouds, Picture 2, was made through a graphic interface from the free IRAMUTEQ software using the abstract of each essay/thesis. The words that highlight the most are the ones that repeated themselves the most on the analyzed projects the difference of size consist on the amount of textual corpus inserted on the system.

Picture 2 - Word Clouds of the Essays/Theses



Fonte: Dados da Pesquisa (2023).

Besides that according with the Picture 2 or the Word Clouds is possible to notice the focus of the investigation are on the students but the theses concentrate their concepts on the teachers training beyond the students.

4. FINAL CONSIDERATIONS

The current article developed 4 out of 6 stages of the state of knowledge in other words it was developed since the choice of the source even the identification and selection of sources. Aligned with the exploratory search of knowledge with the methodology of

knowledge state this project provided the researchers to deepen and to know more about the different productions developed until now, published and defended according with the socio-scientific issues in chemistry.

It's interesting to observe that the analyzed texts, eight essays and four theses explored researches about the SSI, where the analysis was based on the data collection through didactic sequence, investigative teaching sequence and in some cases activities sequence. Although some authors use different kind of terminologies the SSI approach is evident in a practical way on these researches. Even if some of the texts didn't clearly use the terms "Didactic Sequence" or "Investigative Education Sequence" most of them incorporated hands-on activities in their methodologies.

There is still a large field of researches with the SSI in Chemistry education using controversial themes that generate debates and proportionate critical thinking of the students, several themes can be used in Chemistry, such as: pesticides, anabolic substances, drugs, processed food, tea and its chemical substances, garbage and waste disposal, nuclear energy, climate change, biotechnology, toxic chemicals, chemical waste disposal, doping, hydraulic fracturing among others.

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