Appendix: Titles of reviewed studies, including authors, publication years, and variable information

No	Authors, Years	Title	Variables
1	Chen et al. (2014)	Effects of type of exploratory strategy and prior knowledge on middle school students' of chemical formulas from a 3D role-playing game learning	Academic achievement and Motivation
2	Joag (2014)	An effective method of ıntroducing the periodic table as a crossword puzzle at the high school level	Academic achievement
3	Martí-Centelles & Rubio-Magnieto (2014)	ChemMend: A card game to ıntroduce and explore the periodic table while engaging students' interest	Academic Achievement, Attention
4	Weng et al. (2015)	Testing the effect of mnemonic strategy embedded in digital game	Academic Achievement and Attitude towards lesson
5	Franco-Mariscal et al., (2016)	A game-based approach to learning the idea of chemical elements and their periodic classification	Academic achievement and Perception for games
6	Hou et al., (2016)	Chemistry education board game based on cognitive mechanism: multi-dimensional evaluation of learners' knowledge acquisition, flow and playing experience of board game materials	Academic achievement ,Flow experience
7	Cahyana et al., (2017)	Developing and application of mobile game based learning (M-GBL) for high school students performance in chemistry	Academic achievement
8	Hennah & Seery, (2017)	Using Digital Badges for Developing High School Chemistry Laboratory Skills	Academic achievement
9	Hodges et al., (2018)	An exploratory study of blending the virtual world and the laboratory experience in secondary chemistry classrooms	Academic achievement, scientific process skills Engagement
10	da Silva Júnior et al., (2018)	Interactive computer game that engages students in reviewing organic compound nomenclature	Academic achievement
11	Lay & Osman,(2018)	Developing 21st Century Chemistry Learning through Designing Digital Games	Academic Achievement, Motivation, 21st Century Skills
12	Sousa Lima et al., (2019)	Game-based application for helping students review chemical nomenclature in a fun way	Academic achievement
13	Srisawasdi & Panjaburee(2019)	Implementation of game-transformed inquiry-based learning to promote understanding of and motivation to learn chemistry	Academic achievement, Motivation
14	Wang et al.,(2019)	Integrating board game elements, collaborative discussion,and mobile technology to a gamification instructional activity - a case of high school chemical course	Flow and Engagement
15	Boesdorfer & Daugherty, (2020)	Using criteria-based digital badging in high school chemistry unit to improve student learning	Academic achievement and engagement
16	Chen et al.,(2020)	Effects of games on students' emotions of learning science and achievement in chemistry	Academic achievement and Emotions
17	da Silva Junior et al., (2020)	Time Bomb Game: Design, Implementation, and Evaluation of a Fun and Challenging Game Reviewing the Structural Theory of Organic Compounds	Academic achievement
18	Fitriyana et al., (2020)	Android-based-game and blended learning in chemistry: effect on students'self-efficacy and achievement	Academic achievement and self efficacy
19	Rahmahani et al., (2020)	The effect of gamified student response system on students' perception and achievement	Academic achievement, student perveptions
20	Tsai et al., (2020)	Element enterprise Tycoon: Playing board games to learn chemistry in daily life	Academic achievement, engagement
21	Bjørner et al., (2021)	Design and Evaluation of a Serious Game to Supplement Pupils' Understanding of Molecular Structures in Chemistry	Academic achievement and engagement
22	Chen et al. (2021)	The effect of a scientific board game on improving creative problem solving skills	Academic achievement and problem solving skills
23	Fitriyana et al. (2021)	The Influences of hybrid learning with video conference and "Chemondro-Game" on students' self-efficacy, self-regulated learning, and achievement toward chemistry	Academic Achievement, self-efficacy, self-regulated learning

24	Lutfi et al. (2021)	Chemical bonding successful learning using the “Chebo Collect Game”: A case study	Academic achievement , Students` activity
25	Achmad Lutfi et al. (2021)	Applying gamification to improve the quality of teaching and learning of Chemistry in high schools: A case study of Indonesia	Academic Achievement, Engagement
26	Zan et al. (2021)	The Effect of Arabic-Supported Educational Game on the Success of 9th-Grade Syrian Students in the Symbolic Language of Chemistry: Example of Turkey	Academic Achievement
27	Li et al.,(2022)	CHEMTrans: Playing an Interactive Board Game of Chemical Reaction Aeroplane Chess	Motivation and Engagement
28	Nenohai et al., (2022)	Development of Gamification-Based Wordwall Game Platform on Reaction Rate Materials	Engagement
29	Villamor & Lapinid, (2022)	The Use of Gamified Differentiated Homework in Teaching General Chemistry	Academic achievement and motivation
30	Badajos et al., (2023)	Go Carb Deck: A Card Game for Teaching Classification of Simple Monosaccharides	Academic Achievement, Game experience
31	Cahyana et al., (2023)	Improving Students’ Literacy and Numeracy Using Mobile Game-Based Learning with Augmented Reality in Chemistry and Biology	Academic Achievement
32	Chen et al.,(2023)	Design and Development of a Scaffolding-Based Mindtool for Gamified Learning Classrooms	Academic achievement and flow
33	Giron-Gambero & Franco-Mariscal (2023)	“Atomizados”: An Educational Game for Learning Atomic Structure. A Case Study with Grade-9 Students with Difficulties Learning Chemistry	Academic achievement , motivation and students perceptions
34	Hou et al. (2023)	Evaluation of a mobile-based scaffolding board game developed by scaffolding-based game editor: analysis of learners’ performance, anxiety and behavior patterns	Academic achievement, Learners’ anxiety about chemistry
35	Karayel et al., (2023)	ZuKon 2030: An Innovative Learning Environment Focused on Sustainable Development Goals	Engagement
36	Krug & Huwer, (2023)	Safety in the Laboratory—An Exit Game Lab Rally in Chemistry Education	Motivation
37	Lutfi et al., (2023)	Gamification: game as a medium for learning chemistry to motivate and increase retention of students’ learning outcomes	Academic achievement and Motivation
38	Lutfi & Hidayah, (2023)	House of Chemistry as a hydrocarbon learning media for high school students	Academic achievement and Motivation
39	Manzano-Leon et al.,(2023)	Gamification in science Education: Challenging Disengagement in Socially Deprived Communities	Motivation, engagement, and flow
40	Naumoska et al. (2023)	Using the Escape Room game-based approach in chemistry teaching	Motivation and engagement
41	Najib et al. (2024)	STEM-PT Traveler, a game-based approach for learning elements of the periodic table: An approach for enhancing secondary school students’ motivation for learning chemistry	Motivation
42	Rusevska et al.,(2024)	Innovative Learning Activities for Ethnically Diverse Students in Macedonian Science Education	Motivation, Attitudes towards science
43	Saithongdee & Sirirat, (2024)	Learning Mole Calculation through a Board Game in an Engaging and Enjoyable Environment: Design, Implementation, and Evaluation	Academic Achievement, Attitude towards game
44	Atanan & Saithongdee (2024)	Computer Game Development for Balancing Chemical Equations Skill in Chemistry Education	Academic Achievement and Engagement
45	Hu et al., (2024)	Timing of information presentation matters: Effects on secondary school students' cognition, motivation and emotion in game-based learning	Motivation and Cognition
46	Hwang et al., (2024)	Comprehending complex chemistry problems in a structured and enjoyable manner: A concept mapping based contextual gaming approach	Problem-solving tendency, coginitive load and scientific self-efficacy
47	Irwanto et al., (2024)	Exploring high school students’ attitudes towards digital game-based learning: A perspective from Indonesia	Engagement and Attitudes Toward Digital Games
48	Rahman et al., (2024)	Game-based learning in Metaverse: Virtual chemistry classroom for chemical bonding for remote education	Academic achievement, Users’ opinions
49	Debit et al., (2024)	GamesBond: A Game-based supplemental teaching material for ionic and covalent bonding	Academic Achievement and Engagement
50	Chen et al.,(2024)	Effects of escape room game-based civics education on junior high school students' learning motivation, critical thinking and flow experience	Motivation, Critical thinking ability and Flow experience
51	Li et al. (2024)	Chemistry education board game based on cognitive mechanism: multi-dimensional evaluation of learners’ knowledge acquisition, flow and playing experience of board game materials	Academic achievement, Flow experience
52	Lhardy & Reina (2024)	Identificat’ions: A battle card game to learn chemical tests and practice observation and reasoning	Engagement