Technology-Enhanced Learning for Student Agency in Higher Education: a Systematic Literature Review.

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Abstract. From an educational perspective, student agency is a construct that refers to external and internal factors involved in taking responsibility for learning and the possibility of making choices in learning. Although there are studies that back the idea of using educational technologies to support the development of student agency in higher education, there is still a lack of frameworks that relate student agency with technology-enhanced learning. In this study we present a systematic literature review addressing this gap, with emphasis on educational sciences. The results from the mapping of 29 studies show a focus on the micro level of learning design and clear relationships with other concepts, such as ownership of learning or self-regulated learning. The analysis of the results enabled us to develop an own model approach connecting student agency and technology-enhanced learning. Future work will involve iterative phases of revision and validation of the developed model through empirical studies.

Keywords: student agency, technology-enhanced learning (TEL), higher education, educational sciences, systematic literature review.

1 Introduction

In view of the current demands of our society, university graduates should be prepared to address and solve challenges and situations in a creative and efficient way; therefore, universities are expected to support students' training to develop an agentic profile [1]. Furthermore, student agency is included as a central concept in the OECD report on the future of education and skills 2030. According to this report [2], student agency involves that "students have the will and the ability to positively influence their own lives and the world around them as well as the capacity to set a goal, reflect and act responsibly to effect change". One of the core foundations as a basis for developing student agency are cognitive foundations, which include digital and data literacy [2]. Students' digital skills are increasingly important for the professional future, and this affects especially educational professionals. For the purpose of supporting the development of these core foundations of student agency, learning design in higher education, as a "formal process for planning technology-enhanced learning (TEL) activities"[3], seems to be key. The desired result of this process is to have agentic

teachers, who are able to innovate and adapt to the changes and conflicts in a given situation by selecting and using technology in their educational practice [4].

As far as we know, there is no systematised presentation of the elements that link student agency to technology-enhanced learning (TEL) in higher education. Therefore, in this study we address this research gap and contribute to the literature with the analysis of the elements that appear when using technology in relation to the support of the development of student agency in formal learning settings, especially in educational sciences. In doing this, we developed a theoretical model of student agency in TEL in higher education based on learning design, which allows us also to discuss related concepts and offer a framework for further work in the field.

The overarching research question is "What are the characteristics of the relation between student agency and TEL in formal learning contexts within higher education, and particularly in the area of educational sciences?". The research sub-questions are as follows:

- What are the settings in which student agency supported by TEL in educational sciences within higher education have been studied/referred (study design, theories and technologies used) and the conception of student agency on which they are based?
- What are the dimensions involved in the relationship between TEL in educational sciences within higher education and student agency related to learning design?

2 Theoretical Background

Our systematic review is presented through the lenses of a theoretical background from an educational perspective, including as relevant concepts: student agency in higher education, TEL in higher education, and the training of educators' professional identity.

2.1 Student Agency

Student agency has been defined from a broad range of perspectives. While general views understand it as a set of behaviours or abilities that prepare for life, more concrete approaches conceive it as part of the planning of specific learning situations. Van Lier (2008, p.163) in [5] defines agency as "an individual's "contextually enacted way of being in the world" and adds that "the dialogical view of agency has gained ground stressing the individual's own experiences of agency in his/her social environment".

In this sense, agency is understood as the behaviour or human ability to take decisions and select among them (Martín, 2004, cited in [6]), freely choose the own actions consequently [7] and transform structures to answer to the posed problems [8] in a way that prepares for life. On the other hand, [9] retrieve Bandura's work (2001) and consider agency as a dynamic behaviour that is posed to reach a goal and, therefore, that involves intentionality and metacognition. [10] add to this individual and intentional capacity, the students' abilities to be able to act according to the desired

results to prepare themselves for the adult age and take active control of their lives. Therefore, student agency involves control over learning (self-regulated learning) and transforming students themselves in active actors of the own learning, which is closely related to methodological strategies centred on the learner in formal learning contexts [11].

Considering formal learning contexts in higher education, agency is based on different factors related to learning design. Concretely, student agency in higher education is defined by [12] as the "access to (and use of) resources for purposeful action in study contexts, i.e. personal, relational (i.e., interactional), and context-specific resources to engage in intentional and meaningful action and learning, as experienced or interpreted by students". The same authors identified three components as part of the student agency's construct in their Agency of University Students (AUS) instrument: *personal, relational* and *participatory resources*. *Personal* resources refer to students' beliefs concerning their competence and self-efficacy, and their interest and motivation for learning. *Relational* resources are connected to the class climate and include peer support and power relations between lecturer/s and student/s. *Participatory* resources refer to contextual factors that impact on the interactivity in teaching and learning, such as the given opportunities to students for participation, making choices or influence teaching/learning. Along these lines, [13] understand agency as a set of components (cognitive, self-regulatory, motivational and attributional) to achieve the active role of learners in their learning process.

Although these constructs are useful to frame our study, in particular the factors referred by [12], they do not explicitly consider the use of educational technologies as part of them, which is associated to the creation of ecosystems where learning takes place [14]. These ecosystems include "learning design" which, according to [15], is the "description of the teaching-learning process that takes place in a unit of learning [...] and it represents the learning activities and the support activities that are performed by different persons (learners, teachers) in the context of a unit of learning". As [3], we consider these learning activities enhanced by technology (TEL), and we address them in the next section.

2.2 TEL in Higher Education

Although there are a broad number of studies and use experiences of virtual learning environments (VLE) at the universities [16], few of these studies relate the use of VLE to the development of student agency. In fact, student agency has been most commonly associated with Web 2.0 technologies due to their social and participatory nature [17]. In addition, Web 2.0 tools are considered useful for extending and supplementing VLE and can be used to promote more active learning [18]. A valuable framework for classifying these tools is provided by [18]: a) text-based tools such as synchronous text discussion, discussion forums and note taking and document creation, b) image-based tools, e.g. online whiteboarding, mindmapping or image sharing, c) audio tools, including audio sharing and audio creation and editing, d) video tools, similarly to c and adds video streaming, e) multimodal production tools, such as digital pinboards, f) digital storytelling tools, e.g. animated videos, g) website creation tools, including individually created websites, wikis and blogs, h) knowledge organisation and sharing,

e.g. social bookmarking, i) data analysis tools, e.g. infographics, and j) other clusters, such as assessment tools, social networking systems or synchronous collaboration tools. This diverse offer of tools affords a broad range of learning design opportunities for lecturers and the ubiquity of these "digital technologies affords agency in new ways" [19].

Personal Learning Environments (PLEs) leverage these Web 2.0 affordances by emphasizing the shift of control and ownership from the educators to the learners, leaving "decision making and choice upon the learner, [...] first and foremost the choice of the learning tools and the use of these tools to support one's own learning" [20]. This freedom of choices and ownership have been commonly opposed to VLE, due to its teacher-centredness [21]. However, as [17] state, "there is a fine balance to be achieved in attempting to promote learner control, knowledge creation, agency and autonomy by offering flexible options and choice, whilst offering guidance and structure when needed and adding value to the learning process through personalised, customised and adaptive approaches". Therefore, our approach is connected to the idea of institutional PLEs (iPLE), virtual spaces that combine formal and informal learning processes by connecting VLEs (or Learning Management Systems, LMS) and PLEs [21, 22].

Aiming at this balance, the *digital didactics framework* can be highlighted for planning learning design for active learning. We should note that "didactics" is understood here as "education" from the German tradition instead of as "traditional learning", referring to rote learning (English tradition). The digital didactics model embraces digital, pedagogical designs that aim at enabling individual and collaborative learning [23]. From the framework's constructivist perspective, learning is knowledge co-construction as an active process of constructing and this "represents a shift in designing teaching towards learner-centred approaches" [23]. The active involvement of students in their learning requires the acknowledgement of learners' knowledge co-constructions as a main element in a curriculum that fosters self-regulated learning [17]. The digital didactical design, understood as learning design, considers three vertices of a triangle: teaching aims, learning activities and assessment/feedback. The three of them are connected to each other through social relations/social roles and mediated by technology [23]. Therefore, learning design includes the design of teaching objectives, the way these objectives will be achieved (learning activities) and how they will be evaluated (assessment/feedback), but also the design of social relations (teacher-student and student-student) and the design for the use of digital technologies.

Another learning design framework that is relevant to this work is the *activity-centred analysis and design (ACAD) framework*. This model considers learning activities as dynamic and emergent, as well as physically, epistemically and socially situated. Therefore, learning activities cannot be designed, but design (for learning) can influence activity, which in turn mediates outcomes [24]. This design includes three components: physical situation (set design), tasks (epistemic design) and social situation (social design).

The notion of learning activity as emergent, situated and mediator of outcomes from the ACAD framework can be combined with the elements of the digital didactics framework in order to provide insights into the relationship between student agency and TEL in formal learning settings within the context of higher education, and in particular in educational sciences.

2.3 Training Educators' Professional Identity

As [25] states, student agency is related to the development of an identity and sense of belonging. In educational sciences, and especially in initial teacher training, agency gains particular relevance due to several reasons. The most important one is that if initial teacher training is directed at training agentic teachers, these future teachers will be able to transfer skills and abilities related to the ownership of learning and life-long learning to their students. On the other hand, and considering action-theoretical approaches, the role of teacher agency has particular significance in educational change, where agency is concerned with the way in which actors "critically shape their responses to problematic situations" [4]. This is closely connected to the fact that teacher training is situated and social by nature, and to the relation of agency with teacher professional development and the teacher's identity belonging to a part of the community [10]. Furthermore, teachers increasingly need relational agency, which is related to the capacity to work in collaboration with other teachers and with other professionals, and therefore, "being able to utilize the support given by others as well as being a resource for others" [10].

Taking these considerations into account, the concept of transformative agency provides important elements to our theoretical framework. According to [26], transformative agency "is collective, appears in variations and evolves over time, moving from resisting change towards taking actions to change the activity". In the context of initial teacher training, referring concretely to educational innovation, transformative agency relates to six types of transformative agency [26]: 1) resisting change, 2) criticising the current activity, 3) explaining new possibilities, 4) envisioning new patterns or models, 5) committing to specific actions and 6) taking the consequential actions needed to change the activity. These types of transformative agency related to educational innovation can be closely connected to changes concerning the design of TEL scenarios (learning design). For this case, [26] consider a transformative digital agency, which "captures (student) teachers' competence in taking initiatives and transforming their practices by selecting and using relevant digital tools".

3 Method

With the aim to describe and synthesise existing research on student agency related to TEL within higher education in educational sciences, we conducted a systematic literature review, which enabled us to answer the posed research questions based on a concrete search strategy and inclusion and exclusion criteria [27].

We structured this section following the PRISMA reporting guidelines for systematic reviews [28].

3.1 Search Strategy

A search string was collaboratively developed by the three researchers involved in the systematic review. This string was used in the most relevant databases for educational

research in English and Spanish (Education Source, Web of Science, Scopus, ERIC and Dialnet).

The string follows as:

Agency AND learning AND (digital OR techno OR comput*) AND (education OR educational sciences)*

3.2 Eligibility Criteria and Study Selection

The initial search yielded 1,716 references, which were imported into Rayyan, a collaborative system for conducting systematic literature reviews [29]. Out of the total, 189 duplicates were automatically removed by the system and 1,585 titles and abstracts were screened by the three researchers, applying the previously agreed inclusion and exclusion criteria (see Table 1). When one of the researchers had doubts about the exclusion/inclusion of an article, it was marked as *Maybe* and discussed with the others in regular meetings. Additional duplicates that were not removed by Rayyan were still identified at this phase.

This first screening phase led to 149 articles for screening in full text. After the screening on full text of these 149 studies, 29 articles remained for mapping and synthesis. The complete process and reduction in the number of articles can be seen in Figure 1.

Table 1. Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Refers to students' agency in terms of learning or students' self-regulated learning	Refers to agency in other terms different from learning or does not refer to students' agency in learning (e.g. political empowerment)
Involves TEL	Does not include TEL
Higher Education	Levels different than Higher Education
Focus on Educational Studies	Focus on other studies outside Educational Studies
English or Spanish	Languages different from English or Spanish
Publication type: Article	Publication type different from article
Theoretical and empirical studies	

Some remarks related to the methodological decisions and limitations of this systematic review need to be acknowledged. First, since the theoretical papers that we found rarely specified the educational level and/or the discipline, we decided to include them given that: a) the articles provided some valuable insights for our research question, and b) did not concretely address young learners (pre-university learners). Second, although we consider student agency a much more complex construct than self-regulated learning, as we addressed before, student agency is often linked to self-regulated learning [30]; this is why we decided to include this concept among the inclusion criteria. Last but not least, despite the rigor of systematic reviews, we acknowledge that the search strategy (terms, operators, databases) and/or the criteria for inclusion and exclusion (type of publication, language), could be limitations.

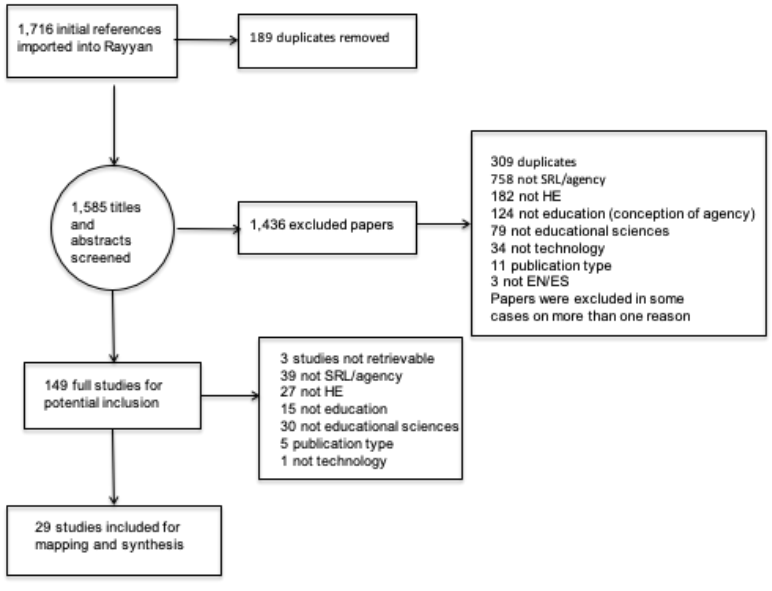

Fig 1. PRISMA chart (based on [28]).

3.3 Data Extraction

The 29 selected articles for mapping and synthesis were uploaded to Atlas.ti Cloud (https://atlasti.com/cloud/), where the three researchers collaborated in iterative coding phases.

The conception of "agency", and even "student agency", has different perspectives in the literature; therefore, and given the diversity of papers, establishing shared understanding among us was more important than calculating an inter-rater reliability (as in [31]).

The initial coding system (categories) used in the first coding phase was developed based on the research questions. The first categories referred to the characteristics of the article (year of publication, country of authorship and discipline of first author), the study design (theoretical or empirical) and the theory behind the study (based on the discipline's traditions). A first basis for the codes for theories was provided by [32]; in addition, we coded concrete theories when some of their key elements were identified, although the theory might not have been explicitly stated (e.g. self-regulated learning, knowledge building). The factors of student agency by [12] (*personal resources, relational resources and participatory resources*) were used as categories for conception of student agency. We considered relevant to integrate an additional one referring to design for learning with technology (*learning design*).

To group codes related to the relationship between TEL and student agency, the framework of digital didactic design [23] was used. In doing so, the elements of the learning design (teaching-related components, learning activities in terms of pedagogical approaches, assessment/feedback, social relationships and technology)

were considered as categories. For the element *technology*, we used the classification of typologies of Web 2.0 by [18] for those corresponding codes, but we needed to expand it with prior and subsequent technologies, as well as with TEL trends that did not correspond to specific tools.

In a second coding phase, but in parallel to the first one, we conducted a content analysis in order to identify new codes in each of the code groups in the articles. This phase is described next.

3.4 Data Synthesis

Due to the complexity and diversity of perspectives of the construct of student agency, we needed to conduct a content analysis to iteratively identify codes, which enabled us to categorise the data systematically and count later the number of times a code appeared (as in [31]).

As a result of the iterative coding process, we adapted and redefined the categories that were previously described with regard to the relationship between TEL and student agency. The final categories, which were embedded in a new model approach developed through our study, were: *teaching, learning activities, learner processes, social relations / roles, assessment / feedback and technology*.

Teaching refers to the relationship between the teacher's role in learning situations in which student agency is involved, and the use of technology. *Learning activities* refer to the pedagogical approaches in which student agency is involved in TEL activities. The dimension *learner processes* was added to the original framework, considering that these are emergent from the learner activity, which in turn mediates relations between learning design (including tasks, roles and tools) and outcome [24] - in our case, related to student agency. Therefore, this dimension relates to all the learning processes in which student agency is involved in TEL activities. The dimension *social relations / roles* includes the relationships built with others when student agency is enacted in TEL situations. The dimension *assessment / feedback* includes elements related to support, feedback, reflection,… when TEL is connected to student agency. On the other hand, the dimension *technology* was extended to include other technologies and TEL trends different from Web 2.0.

Codified data were exported from Atlas.ti Cloud into Excel files to collaboratively remove, reorganise and merge codes in the (re)designed categories. In doing so, the different codes and their classification in the categories were discussed.
The final coding system, including categories and codes, was, therefore, jointly developed, agreed and discussed iteratively in regular meetings (see Table 2 and 3).

Against this backdrop, we present the results according to the above-mentioned research questions. In order to characterise the sample, general information about the studies in terms of publication year, country of affiliation and disciplines of the first author is provided. In addition, these data could give us an idea about the interest on the topics of the current study and the geographical and disciplinary areas involved.

The summary table with the overview of the 29 analysed articles along with the coding schemes used is included in Appendix 1.

Table 2. Coding scheme (I).

Study Design		**Theory behind the study**	**Conception of student agency**				**Technology/TEL trend**	
Theoretical	*Empirical*	*Theory*	*Personal resources*	*Relational resources*	*Participatory resources*	*Learning design*	*Web 2.0*	*Other technologies / TEL trends*
	Qualitative	Social cognitive theory	Learner autonomy	Interaction	Choice making	Assessment	General (social software)	Learning Management Systems (LMS)
	Quantitative	Sociocultural learning	Metacognitive regulation	Collaboration	Learner control	Educational roles	Video creation and editing (video tools)	Computer supported Collaborative Learning (CSCL)
	Mixed methods	Social constructivism	Self-regulated learning	Sociocultural context	Forethought	Digital (co)design	Wikis (website creation tools)	Personal Learning Environments (PLE)
		Connectivism	Engagement	Social learning	Negotiation	Pedagogical conception	Synchronous text discussion (text-based tools)	Mobile learning
		Critical pedagogy	Reflective learning				Blogs (website creation tools)	Learning analytics
		Theory of the social capital	Motivation				Social networking systems (other clusters)	Massive Open Online Courses (MOOC)
		Communication theory	Ownership of learning				Note taking and document creation (text-based tools)	Artificial Intelligence in Education (AIED)
		Theory of the psychological contract	Active learning				Online whiteboarding (image-based tools)	Flipped learning

Actor-network theory	Self-directed learning		Animated videos (digital storytelling tools)	e-Assessment
Theory of the transactional control	Self-expression		Individually created websites (website creation tools)	Interactive whiteboard
New materialism	Learning to learn		Aggregators (knowledge organisation and sharing)	Augmented reality
Critical realism			Audio creation and editing (audio tools)	Digital media (general)

Table 3. Coding scheme (II).

Relationship between TEL and student agency					
Teaching	*Learning activities*	*Learner processes*	*Social relations / roles*	*Assessment / feedback*	*Technology*
Change of roles	Knowledge building	Ownership of learning	Collaborative learning	Guidance / support	Web 2.0
Pedagogical innovation / change	Do it yourself	Learner autonomy	Learning community	Assessment of learning	Other technology / TEL trends
Personalisation of learning	Inquiry-based learning	Self-regulation	Peer support	Personalised feedback	
Instructional design	Problem solving	Reflection on learning	Development of social skills		
	Development of learning experiences	Learner control			
		Engagement			

Motivation

Self-directed learning

Student participation

Logistical choices (technology, place, time)

Proactivity

Creativity

Ownership of technology

Informal learning

Influence of student profile

Lifelong learning

Learning satisfaction

4 Results

4.1 Characteristics of the studies

The publication year of the studies shows an increasing interest in the topic of student agency and TEL (see Figure 2), with 2018 and 2019 being the years with the highest number of references, and an increasing interest since 2016. However, as we will remark later and as the titles of the articles show, many of these studies are not concretely focusing on our research object; this is rather an indirect interest (and effect).

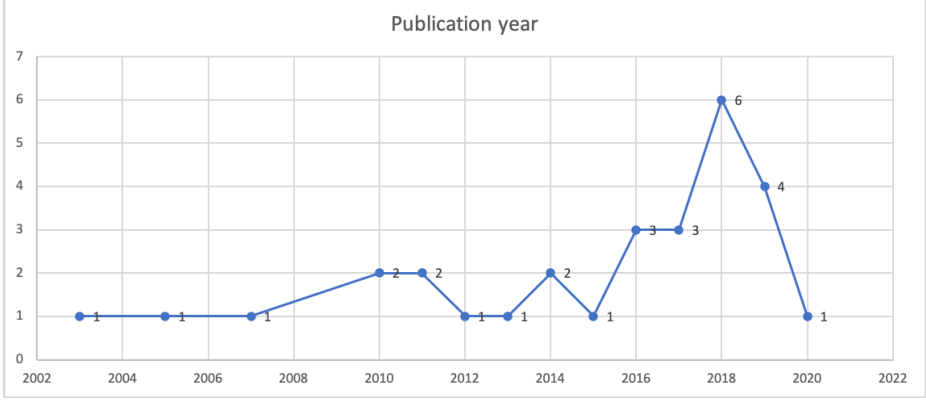

Fig. 2. Publication year of the studies (n=29).

Considering the country of affiliation of the first author, we analysed the geographical distribution of the articles. Table 4 shows that authors from 15 countries were involved in the articles of our sample. Australia (n=5), the United States (n=5) and the United Kingdom (n=4) are found to be the major contributors in our sample. Interestingly enough, the three countries are part of the so-called developed countries or from the Global North, and also English-speaking countries.

As for the country of affiliation, we considered the discipline of the first author in each article (see Table 5). Researchers from departments of educational sciences were the major contributors to the topic of study (n=18), followed by computer scientists (n=6). This is coherent with the focus of our study, which is related to the concept of agency from the perspective of learning, but also with the inclusion criteria of studies conducted in educational sciences.

Table 4. Articles by country (n=29).

Country	n	%
Australia	5	17.2 %
United States	5	17.2 %
United Kingdom	4	13.8 %
China	2	6.9 %
The Netherlands	2	6.9 %
Spain	2	6.9 %
South Africa	1	3.4 %
France	1	3.4 %
Italy	1	3.4 %
Singapore	1	3.4 %
Norway	1	3.4 %
Sweden	1	3.4 %
Ukraine	1	3.4 %
Canada	1	3.4 %
Finland	1	3.4 %

Table 5. Disciplines (n=29).

Discipline	n	%
Education	18	62.1 %
Computer Science	6	20.7 %
unknown	2	6.9 %
Arts, Humanities & Social Science	1	3.4 %
Psychology	1	3.4 %
STEM (Science, Technology, Engineering, Mathematics)	1	3.4 %

Table 6. Dimension *Personal resources*. Note: several codes could appear in the same article.

Personal resources	n	%
Learner autonomy	13	16.9 %
Metacognitive regulation	10	13.0 %
Self-regulated learning	10	13.0 %
Engagement	8	10.4 %
Reflective learning	7	9.1 %
Motivation	7	9.1 %
Ownership of learning	7	9.1 %
Self-directed learning	7	9.1 %
Active learning	6	7.8 %
Self-expression	1	1.3 %
Learning to learn	1	1.3 %

4.2 Conception of student agency

Different types of agency related to student agency were identified in our sample. This variety answers to the diversity of conceptions that the term has [25]. For example, collective agency (n=4) was one of the most common types of agency referred, involving the idea of individual persons acting together for, e.g., a community with a shared responsibility and a sense of identity and belonging [25]. Another example is proxy agency (n=3), which focus on a socially mediated agency that is exerted on others when there is no direct control over situations [33]. Nevertheless, the aim with our research question concerning the conception of student agency is connected to the elements that were used to understand the construct, rather than to identify types of agency. Therefore, we present those elements as follows.

Following the framework of student agency by [12], we used the three main components of student agency (*participatory resources, relational resources and personal resources*) and we added an extra one that refers to the design for learning with technology (*learning design*). In terms of participatory resources, we could identify four elements in our sample: choice making (n=12), learner control (n=5), forethought (n=1) and negotiation (n=1). The connection of student agency and TEL is closely related to the possibility of making choices and the learner control, as we will also show in the next section. Concerning relational resources, the following elements were identified: interaction (n=6), collaboration (n=6), sociocultural context (n=5) and social learning (n=4). Therefore, relational resources in terms of interaction, collaboration and social learning are important in order to experience student agency when using technology for learning. Personal resources are the most populated in our sample when it comes to relate student agency and TEL. Many concepts within the personal resources reaffirm the individual part of the learner to take responsibility of learning and to self-regulate metacognitive skills (see Table 6).

The new dimension for the framework (learning design) concerns the design of TEL scenarios that support student agency. Aspects related to assessment (n=6), educational roles (n=6), digital (co)design (n=3) and the pedagogical conception (n=2) emerge. It is remarkable that assessment appears in connection to learning designs directed towards student agency with TEL, although it can be understood in light of the formal learning contexts in which they are embedded.

4.3 Learning settings

Within this section we analysed the learning settings of the sample, in terms of study design, theories behind the studies and the technologies that were used.

Concerning the design of the study, most of the papers in our study were either theoretical (n=12) or empirical qualitative (n=10) (see Fig. 3). Studies that used mixed methods (n=4) or purely quantitative methods (n=3) were less common.

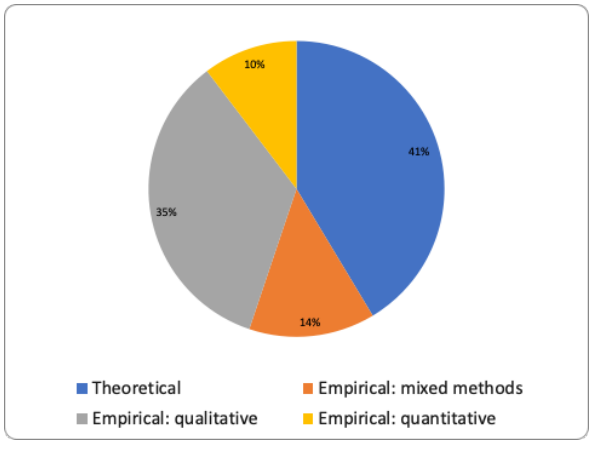

Fig. 3. Design of the studies (n=29).

The theories or theoretical constructs behind the studies were varied and came from different discipline traditions, including psychology (Ps) (6 theories), interdisciplinary perspectives (I) (2 theories), and social anthropology (SA), education (Ed), sociology (So) and communication (C), with one theory respectively (see Table 7). The most repeated theory was the social cognitive theory (n=6) from the psychological tradition (e.g., [34]). Within the social cognitive theory, the theory of self-efficacy from Bandura (n=2) and the construct of self-regulated learning from Zimmerman (n=3) are major elements for student agency. The second most common theory was social constructivism (psychology) (n=4) and includes as a main concept "knowledge building" (Scardamalia & Bereiter) (n=3) (e.g., [35]). The third most referred theory was the sociocultural learning theory (n=3) (e.g., [36]), which includes the situated learning theory (Lave & Wenger) and the concepts of "zone of proximal development" (Vygotsky) and "scaffolding" (Bruner). Other theories were only present in one study. Interestingly enough, there was only a theory derived from the educational sciences (critical pedagogy).

Although some of the theories are close to each other, there are some nuances to take into account. For instance, social constructivism can be contrasted with the social cognitive theory by stressing interaction over observation. The theory of transactional control from Dron builds upon the well-known theory of transactional distance and focuses on the relationship between three variables in distance learning: structure and dialogue between teacher-learner and learner autonomy.

Concerning the technologies used/mentioned in the studies, we considered tools but also TEL trends in which no specific tool was mentioned, but where concrete technologies were implicit (see Table 8). For Web 2.0 tools, typologies according to [18] were applied. However, other technologies different from Web 2.0 were also used in the studies, so prior and subsequent technologies and trends were also considered. Most of the tools in the studies were among the Web 2.0 or social software (n=21) (e.g., [39, 40]). LMS, such as Blackboard, Moodle and Google Classroom (e.g., [41]), whereas CSCL among Web 1.0 tools were far behind (n=7 and n=6, respectively). In addition, it should be noted that in some studies where LMS were considered, only

Table 7. Theories behind the studies. Note: in two articles [37, 38] two theories in each one were identified, and it was not possible to identify theoretical foundations in 9 articles. Ps: Psychology, SA: Social anthropology, I: Interdisciplinary perspectives, Ed: Education, Co: Communication and So: Sociology.

Theory or theoretical construct	n	%
Social cognitive theory (Ps)	6	27.3 %
Social constructivism (Ps)	4	18.2 %
Sociocultural learning (Ps)	3	13.6 %
Critical pedagogy (Ed)	1	4.5 %
Connectivism (Ps)	1	4.5 %
Theory of the social capital (So)	1	4.5 %
Actor-network theory (SA)	1	4.5 %
Theory of the transactional control (Ps)	1	4.5 %
New materialism (I)	1	4.5 %
Critical realism (I)	1	4.5 %
Communication theory (Co)	1	4.5 %
Theory of the psychological contract (Ps)	1	4.5 %

Table 8. Technology / TEL trend used in the studies. Note: several codes could appear in the same article.

Technology or TEL Trend	n	%
Web 2.0	21	42.9 %
General (social software) *(n=3)*		
Video creation and editing *(n=3)*		
Social networking systems *(n=3)*		
Synchronous text discussion *(n=2)*		
Blogs *(n=2)*		
Wikis *(n=2)*		
Individually created websites *(n=2)*		
Animated videos (animations, digital storytelling) *(n=1)*		
Note taking and document creation *(n=1)*		
Audio creation and editing *(n=1)*		
Aggregators *(n=1)*		
Learning Management Systems (LMS)	7	14.3 %
Computer supported Collaborative Learning (CSCL)	6	12.2 %
Mobile learning	3	6.1 %
Personal Learning Environments (PLE)	2	4.1 %
e-Assessment	2	4.1 %
Digital media (general)	2	4.1 %
Learning analytics	1	2 %
Massive Open Online Courses (MOOC)	1	2 %
Artificial Intelligence in Education (AIED)	1	2 %
Flipped learning	1	2 %
Interactive whiteboard	1	2 %
Augmented reality	1	2 %

concrete tools integrated or within the LMS, which have characteristics of the Web 2.0 or subsequent trends (n=4), were discussed; e.g., Open Badges (e-Assessment) [33], or in combination with other Web 2.0 tools (e.g., Aggregator, blogs, etc., in [42]). Among CSCL, Knowledge Forum seemed to be a common tool for knowledge sharing, but also a part of e-portfolio creation (e.g., [43]). TEL trends that were mentioned in some of the studies, without specifying concrete tools, were mobile learning (n=3) (e.g., [44]), PLE (n=2) (e.g., [37]) - which were mostly connected to Web 2.0 in the studies but may be related to other technologies (see iPLE, [22]) –, and e-Assessment (n=2) [36]. Other technologies / TEL trends appeared only in one study.

4.4 Relationship between TEL and student agency

Based on the framework of digital didactic designs [23], we developed iteratively a new model approach, as was described in the Method section. This developed approach included 6 key dimensions: *teaching, learning activities, learner processes, social relations/roles, assessment/feedback and technology*. These dimensions are analysed in our sample as follows. The exception is technology, which was already addressed separately before.

The dimension *teaching* was sparsely populated in terms of codes in the studies: change of roles (n=5), pedagogical innovation / change (n=3), personalisation of learning (n=2) and instructional design (n=2). Interesting to highlight within this dimension is the reference to the change of roles in teaching and learning: teacher as a facilitator or as a guide, and students as active actors in their learning; both cornerstone in student agency. For example, in [17], this change was explicitly tied to technology: "Many social software tools afford greater agency to the learner by allowing autonomy and engagement in global communities where ideas are exchanged and knowledge is created as students assume active roles".

In terms of *learning activities*, we could identify perspectives such as knowledge building (n=4), do it yourself (n=1), inquiry-based learning (n=1), problem solving (n=1) and the development of learning experiences (n=1). Student agency seemed to be a relevant approach in terms of knowledge building, as [45] showed in his design in a teacher training course where a CSCL tool (Knowledge Forum) was used: "there was a deliberate attempt to engage the participants in knowledge building practices, which include (1) engagement in knowledge building discourse, and (2) the constructive use of authoritative sources of knowledge. […] Finally, throughout the 13 weeks, the instructor was committed to developing a classroom culture which encouraged (1) the participants to assume collective cognitive responsibility in helping one another in learning and improving their knowledge artifacts, and (2) the participants in assuming epistemic agency or ownership in their learning".

By far, the most populated and relevant dimension within the framework was *learner processes* (see Table 9). Learner autonomy appeared as the most common topic in our sample (n=13). An example of its connection to TEL appears, e.g. in [46]: "we were pleased to see some students recognize that Google Classroom allowed them greater autonomy over their own learning". The second most frequent topic was ownership of learning (n=12), referring to the responsibility in the own learning. An example of this element that refers to TEL can be found in [17] with the following statement "the integration of social software into learning design can make a qualitative difference to giving students a sense of ownership and control over their own learning and career planning". Self-regulation occupied second place with ownership of learning (n=12), and included metacognitive regulation (planning of learning, self-monitoring, self-evaluation). The connection to learning technologies can be observed, e.g. in [42]: "Learning how the new environment might improve their teaching and the learning of others was one of the motivational factors, while the topic of discussion was another. One participant highlighted the issues of self-evaluation, self-orientation, and self-regulation as important in relation to motivation in connectivist learning".

Table 9. Dimension *Learner processes*. Note: several codes could appear in the same article.

Learner processes' related codes	n	%
Learner autonomy	13	13.1 %
Ownership of learning	12	12.1 %
Self-regulation	12	12.1 %
Learner control	10	10.1 %
Engagement	8	8.1 %
Motivation	8	8.1 %
Reflection on learning	8	8.1 %
Self-directed learning	7	7.1 %
Student participation	6	6.1 %
Logistical choices (technology, place, time)	4	4 %
Creativity	2	2 %
Learning satisfaction	2	2 %
Ownership of technology	2	2 %
Proactivity	2	2 %
Influence of student profile	1	1 %
Informal learning	1	1 %
Lifelong learning	1	1 %

Four main topics emerged within the dimension *social relations / roles*: collaborative learning (n=7), learning community (n=3), sometimes in the form of community of practice, peer support (n=3) and the development of social skills (n=2). Looking at this dimension, we can observe that student agency emerged also in social relationships in TEL situations, especially in collaborative learning, and potential and tensions also emerged, as shown in [41]: "A digital storytelling activity was designed using connected learning principles to create an authentic, production-centered task scenario and opportunities for peer support, social connection, shared expertise, and collaboration. Results suggest that the connected learning activity opened up a space for preservice teacher agency through student choice, experimentation and risk taking, and peer support. However, some of the preservice teachers experienced a tension

between wanting control and freedom, and their ability to engage in the self-regulation necessary in order to bring their projects to fruition".

The topics identified within the dimension *assessment / feedback* are guidance/support (n=7), assessment of learning (n=5) and personalised feedback (n=3). Concerning guidance, some tensions related to the entailed conception of student agency can arise, as [47] noted: "On the one hand, there is the question of learners' autonomy. Arguments include ethics and general educational values, the respect of learners' collective self-determination and, for some researchers, the fact that autonomy is a sine qua non condition for authentic collaboration and learning. On the other, there is a well-known pedagogical issue: unless supported, learners often do not develop fruitful and learning-generative collaborations".

5 Discussion

The results of our study reflect some of the statements of [25] concerning the range of different perceptions and interpretations of agency around the world, but also emphasise "the notion of students playing an active role in their education" and learning involving co-construction. On the other hand, although there are terms that are definitely related to student agency, such as "learner autonomy", "student voice", or "student choice", student agency goes beyond them, being something learnable and malleable and not a personality trait [25]. Similarly, self-regulated learning is a closely related construct, but it does not embed relational and social aspects or the development of an identity and a sense of belonging, all of them involved in student agency.

Our sample shows ways of developing agency (to varying degrees) through the use (or reference to the possible use) of technology mostly in formal learning contexts within higher education and reaffirms the potential of digital tools, in particular Web 2.0 tools for their affordances in terms of boosting active learning [18], to support this capability. Furthermore, since Web 2.0 technologies are commonly used in technology-mediated informal learning activities by young people, we could envisage even a higher effect on developing student agency when using these tools outside the boundaries of formal education [48]. However, the presence of other kind of technologies in our sample points towards the idea of iPLE [22] for developing student agency in TEL situations.

On the other hand, the dimensions and elements found in the relationship between student agency and TEL clearly refer to the micro level of teaching and learning (learning design), leaving out components connected to the macro (context) and meso (institutional strategies) levels [49]. Dimensions such as *teaching, learning activities and assessment/feedback* seem to be involved in a lesser degree than *social relations / roles and learner processes*. This seems consistent with the understanding of student agency addressed in the theoretical framework. Likewise, the dominant presence of topics related to guidance and support within *assessment/feedback* seems also sensible in approaches that address student agency in TEL situations. Little attention is given to assessment from a participative model [50] where we can go beyond summative assessment and include co-assessment and self-assessment [51], which involve a deeper level of student involvement and agency [52].

The dimension of *learner processes* relates to the idea that developing student agency is both a learning goal and a learning process, and the social relationship dimension connects to the development of agency as a relational process that involves interactions with others over time [25]. The studies show that TEL design is effective when developing student agency within higher education in educational sciences, and point towards different aspects involved that are positively fostered (e.g. ownership of learning, learner autonomy, self-regulation, reflection on learning, learner control, engagement). In addition, some studies highlight the tensions related to the development of student agency in TEL, e.g. the restrictions that CSCL scripts impose, or the balance between wanting control and freedom, and students' self-regulatory abilities [37, 41, 53].

Learning scenarios with Web 2.0 tools in mainly collaborative settings were the most effective ones in terms of pointing out relations between TEL and student agency, especially learner processes, but also social relations / roles (e.g. [40, 54]). This collaborative setting could also explain the popular use of groupware and other CSCL tools that are related to student agency in our sample (e.g., [35, 47, 53, 55]). Although LMS appear as the second most common tools used in the studies, it is in combination with other (Web 2.0) tools when more connections to student agency are identified (e.g. connectivist MOOC in [42]; digital storytelling in [41]). Promising prospects are envisaged for mobile learning, PLE, e-Assessment and learning analytics; however, their anecdotal appearance suggests that more (and empirical) research needs to be conducted with this regard [34, 37, 44, 56].

In terms of theories, the studies with theoretical basis of connectivism, critical pedagogy, sociocultural learning, social constructivism and social cognitive theory when referring to the construct of self-regulation, were the ones most frequently connected to relations between TEL and student agency. The almost non-existent educational theories supporting our research object encourages the development of models that explain student agency in light of educational perspectives and justify firmly the current contribution.

The model approach, with the dimensions identified in the systematic review, is presented in Figure 4. The models of [12] and [23] have been useful in the first phases of the analysis as reference frameworks to locate the elements related to TEL and student agency in higher education. The ACAD framework [24] serves also as a relevant framework to set our dimensions, considering epistemically situated (tasks) the part of teacher design and role, socially situated (roles, groups) the social relations / roles and physically situated (tools) the technology used. All them contribute to the emergent activity in terms of learner processes. The objective is to design learning scenarios that promote student agency understood as the "capacity to set a goal, reflect and act responsibly to effect change" [2], but also that develop digital competence as an individual, and more importantly in this case, digital competence as educator. This competence would include the ability to apply, effectively and meaningfully, technology in their teaching practice in the future as educators.

Even though our systematic review focused on educational studies, we could venture that the approach could be useful for other disciplines too.

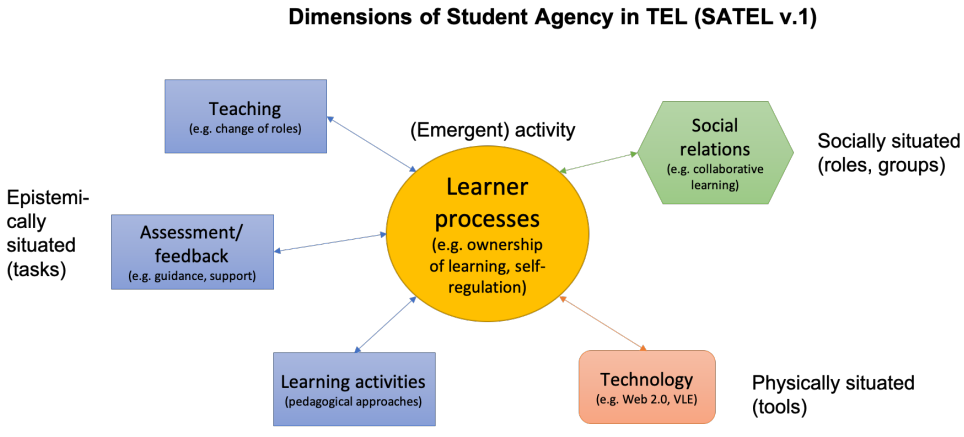

Fig. 4. Model approach to the dimensions of student agency in TEL within higher education (SATEL v.1).

6 Conclusions

This is a contribution to a first model approach in terms of TEL design for enhancing student agency in formal learning contexts within higher education with a focus on educational sciences. New and iterative phases of revision and validation through implementation are needed as part of our future work to adjust the new model, interpret the relationships between the dimensions and understand the results of the systematic review in light of own empirical results.

Our findings need to be considered in the light of the fact that most of the analysed studies did not have their research focus on the concept of student agency or the use of TEL to support student agency (see Description of the study in Appendix 1). This situation could also partially explain the lack of definition and linkage to particular theoretical frameworks or traditions for the term (student) agency, despite its interest [41]. In addition, and considering the limitations of the method, we have ascertained that no studies that relate future teachers' agency with TEL are currently available. Therefore, we can affirm that our work contributes to define and characterise student agency in relation to TEL, with special emphasis on educational sciences and teacher training.

As [1, 2] state, our current society demands to support the development of student agency (and especially future teachers agency) within the universities, in order to equip students with the abilities of making responsible decisions and choices and of influencing people and society. Considering students as partners and bring them to co-creation of learning and teaching in higher education may be a suitable way to do it [57]. The universities' mission of supporting student agency is still to be fully fulfilled and we can definitely make valuable contributions to it with TEL (co-)designs at this level. Future research and practice should point towards this direction.

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Appendix 1

Overview of the codes within the studies (n=29)

A file with the references to the sample is shared on Researchgate: http://dx.doi.org/10.13140/RG.2.2.28381.23522/1

No. Study	Study design	Theory	Conception of learner agency	Technology / TEL trend	Relation between TEL and student agency	Description of the study
1. Brox (2017)	Qualitative	Actor-network theory New materialism	- Relational resources (Interaction) -Participatory resources (Learner control)	Note taking and document creation (collaborative pads) Wikis	- Learner processes (Motivation, Ownership of technology, Learning satisfaction) - Social relations / roles (Collaborative learning)	This paper reports from a collaborative creative writing project in teacher education that involved the use of wikis (p. 129).
2. Charteris, Quinn, Parkes, Fletcher & Reyes (2016)	Theoretical	Sociocultural learning	- Personal resources (Learner autonomy, Active learning, Reflective learning, Ownership of learning, Engagement) - Relational resources (Interaction, Collaboration, Sociocultural context) - Participatory resources (Choice making) - Learning design (assessment, digital (co)design)	e-Assessment	- Learner Activities (Problem solving) - Learner processes (Ownership of learning, Learner autonomy, Engagement) - Social relations/ roles (Learning community) - Assessment/ feedback (Assessment of learning)	This paper provides a critical and contextualised exploration of assessment for learning (AfL) as an important area of scholarship in higher education, particularly in online learning environments (p. 112).
3. Colas Bravo, de Pablos Pons, Reyes de Cozar & Conde Jimenez (2018)	Theoretical	-	- Personal resources (Learner autonomy, Metacognitive regulation, Motivation) - Relational resources (Social learning)	Video creation and editing Social networking systems	- Teaching (Pedagogical innovation/ change) - Learner processes (Learner autonomy, Motivation) - Social relations / roles (Collaborative learning, Development of social skills)	The purpose of this contribution is to provide an overview on the pedagogical possibilities of social networking sites and online videos for paradigmatic change in pre-service and in-

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						service teacher training (p. 163).
4. Costa, Murphy, Pereira & Taylor (2018)	Qualitative	Critical pedagogy	- Personal resources (Learner autonomy, Engagement) - Learning design (pedagogical conception)	Blogs Video creation and editing Animated videos (animations, digital storytelling) Synchronous text discussion (Twitter) Social networking systems	- Learner processes (Student participation, Learner autonomy, Engagement)	This paper focuses on learning practices in higher education in relation to a digital participatory culture. Using key principles of critical education, the research set out to explore higher education students' sense of agency online – or lack of it –as part of their formal learning practices (p. 140).
5. Dziuban, Moskal, Kramer & Thompson (2013)	Quantitative	Theory of the psychological contract	- Participatory resources (Learner control) - Personal resources (ownership of learning) - Learning design (assessment)	Learning Management System (LMS)	- Learner processes (Ownership of learning, Learner control) - Assessment / feedback (Assessment of learning)	The authors explore the possible relationship between student satisfaction (engaged learning, agency, and assessment) with online learning and the theory of psychological contracts (p. 1).
6. Evans (2011)	Theoretical	Critical realism	- Personal resources (Metacognitive regulation) -Relational resources (Social learning)	Digital media (general)	- Teaching (Instructional design)	The author presents possible weaknesses in a radically constructivist-inspired position (postmodern agenda) concerning instructional design and technology theory and research, and,

						in the spirit of scholarly dialogue, counter with a critical-realist perspective that presents a potentially more innovative and defensible approach to the discovery of scientific knowledge about teaching and learning infused with technology (p. 799).
7. Hatzipanagos & Code (2016)	Qualitative	Social cognitive theory	-Personal resources (Self-regulated learning, Engagement) -Relational resources (Interaction)	e-Assessment (Open Badges) Learning Management System (LMS)	- Learner processes (Self-regulation, Engagement)	This paper presents how engagement and agency are interrelated, and the role of this relationship in online learning - particularly in formative assessment and peer feedback. (p. 127)
8. Heggart & Yoo (2018)	Mixed methods	-	-Personal resources (Learner autonomy)	Learning Management System (LMS)	- Learner processes (Student participation, Learner autonomy)	In this study, two early career academics and instructors examined the effectiveness of using Google Classroom for final year primary teacher education students to encourage student voice and agency, and to consider how the platform might influence future pedagogies at the tertiary level (p.140).

9. Kay & Kummerfeld (2019)	Theoretical	Social cognitive theory	-Personal resources (Reflective learning)	Artificial Intelligence in Education (AIED)	- Teaching (Instructional design) - Learner processes (Self-regulation, Reflection on learning)	The paper introduces a conceptual model for a Personal User Model for Life-long, Life-wide Learners (PUMLs) to give learners both control over their own learning data and the means to harness that data for the important metacognitive processes of self-monitoring, reflection and planning (p. 2871).
10. Kop & Fournier (2011)	Mixed methods	Connectivism	-Personal resources (Learner autonomy, Active learning, Reflective learning, Metacognitive regulation, Self-regulated learning, Self-directed learning, self-expression) - Relational resources (Collaboration)	Aggregator Massive Open Online Courses (MOOC) (connectivist MOOC) Learning Management System (LMS) Blogs Synchronous text discussion (Twitter) Social networking systems	- Teaching (Pedagogical innovation / change) - Learner processes (Creativity, Self-regulation, Self-directed learning, Reflection on learning, Learner autonomy) - Social relations / roles (Learning community)	This research analyzed the agency and level of autonomy required by learners participating in a MOOC (p. 2).
11. Kress & Selander (2012)	Theoretical	Communication theory	- Relational resources (Interaction) -Participatory resources (Choice making, Negotiation) - Learning design (assessment, educational roles)	Digital media (general)	- Learner processes (Ownership of learning - Assessment / feedback (Assessment of learning)	In this article, a design-oriented, multimodal understanding of learning is outlined (p. 265).
12. Ligorio, Impedovo & Arcidiacono (2017)	Qualitative	Social constructivism	-Personal resources (Learner autonomy, Active learning, Reflective learning, Metacognitive	Computer supported Collaborative Learning (CSCL) (webforums in the platform Synergeia)	- Learner processes (Proactivity, Reflection on learning, Learner autonomy, Engagement)	This article aims to investigate how university students perform agency in an

			regulation, Self-regulated learning, Self-directed learning, Engagement) - Relational resources (Collaboration, Sociocultural context) -Participatory resources (Choice making, forethought)		- Social relations / roles (Learning community, Collaborative learning, Peer support) - Assessment / feedback (Guidance / support)	online course and whether the collaborative nature of the course affects such expression (p. 529)
13. Lohnes Watulak (2018)	Qualitative	Sociocultural learning	-Personal resources (Self-regulated learning, Motivation) - Relational resources (Collaboration) -Participatory resources (Choice making)	Learning Management System (LMS) Interactive whiteboard Augmented reality (QR codes) Video creation and editing Individually created websites (e-portfolio)	- Learner processes (Ownership of learning, Self-regulation, Learner control, Motivation) - Social relations / roles (Peer support, Development of social skills) - Assessment / feedback (Guidance / support)	This study examined two stand-alone educational technology courses that used the connected learning design framework to reimagine a digital storytelling unit as an authentic, production-centered task scenario with opportunities for peer support, social connection, shared expertise, and collaboration (p. 166).
14. Luo, Yang, Xue & Zuo (2019)	Quantitative	-	-Personal resources (Learner autonomy, Active learning, Metacognitive regulation, Self-directed learning) - Relational resources (Interaction, Sociocultural context) -Participatory resources (Choice making)	Flipped learning	- Teaching (Change of roles) - Learner Activities (Development of learning experiences) - Learner processes (Ownership of learning, Logistical choices (technology, place, time), Influence of student profile, Self-directed learning, Reflection on learning,	With the purpose of prescribing the optimal level of student agency for the flipped classroom, this study conducted a repeated-measures experimental design to compare the effects of three levels of student agency in an undergraduate flipped course (p. 819).

			- Learning design (assessment, educational roles)		Learner autonomy, Learning satisfaction)	
15. McLoughlin & Lee (2010)	Theoretical	Social cognitive theory	-Personal resources (Learner autonomy, Reflective learning, Ownership of learning , Self-regulated learning. Self-directed learning, Engagement) -Participatory resources (Choice making) - Learning design (assessment, educational roles)	General (social software)	- Teaching (Pedagogical innovation / change, Personalisation of learning, change of roles) - Learning Activities (Knowledge building) - Learner processes (Ownership of learning, Creativity, Informal learning, Self-regulation, Self-directed learning, Reflection on learning, Learner control, Student participation, Learner autonomy, Engagement, Lifelong learning) - Assessment / feedback (Guidance / support, Assessment of learning)	In this article, it is argued that in order for self-regulated learning to come to fruition, students need not only to be able to choose and personalise what tools and content are available, but also to have access to the necessary scaffolding to support their learning. Emerging practices with social computing technologies, a number of examples of which are showcased in this article, signal the need for pedagogies that are more personal, social and participatory (p. 28).
16. Muukkonen, Lakkala & Hakkarainen (2005)	Qualitative	Social constructivism	-Personal resources (Metacognitive regulation, Self-regulated learning, Engagement) - Relational resources (Collaboration) - Learning design (Digital (co)design)	Computer supported Collaborative Learning (CSCL) (FLE, asynchronous groupware system)	- Learning Activities (Knowledge building) - Learner processes (Self-regulation, Engagement) - Social relations / roles (Collaborative learning)	The objective of this research is to explore pedagogical structures that direct students' efforts into taking responsibility for self-regulative processes that enhance commitment to inquiry and facilitate deepening their inquiry processes (p. 537).

17. Rahimi, van den Berg & Veen (2015)	Theoretical	Social cognitive theory Theory of the transactional control	-Personal resources (Learner autonomy, Reflective learning, Ownership of learning,Motivation) -Participatory resources (Choice making) - Learning design (Educational roles)	General (social software) Personal Learning Environments (PLE)	- Teaching (Change of roles) - Learner processes (Ownership of learning, Logistical choices (technology, place, time), Ownership of technology, Reflection on learning, Learner control, Learner autonomy, Motivation) - Assessment / feedback (Personalised feedback)	This paper focuses on proposing a learning model built upon self-regulated learning and student's control theories and concepts, and supported by the learning affordances of Web 2.0 tools and technologies for enhancing student's control by developing and applying Web 2.0 PLEs (p. 780).
18. Sancho-Gil & Rivera-Vargas (2016)	Qualitative	-	-Personal resources (Self-regulated learning) - Learning design (Pedagogical conception)	General (social software) (in DIYlab)	-Learning activities (Do it yourself) - Learner processes (Self-regulation) - Social relations / roles (Collaborative learning)	The aim of this study was to deeply and sustainably transform teaching and learning practice in primary and secondary schools and higher education, by introducing Do it Yourself (DIY) philosophy in order to expand digital competence and foster students' agency and collaborative learning (p. 1).
19. Sharkova (2014)	Qualitative	Sociocultural learning	-Personal resources (Active learning, Metacognitive regulation, Engagement) - Relational resources (Social learning, Interaction, Collaboration, Sociocultural context)	Learning Management Systems (LMS) Wikis Individually created websites	- Learner processes (Proactivity, Self-regulation, Learner control, Student participation, Engagement) - Social relations / roles (Collaborative learning)	The paper analyses the ICT-supported activities employed by teachers in four different types of courses: a) face-to-face (f2f) with a formal use of ICT; b) f2f with a creative use of ICT; c)

			-Participatory resources (Choice making, Learner control) - Learning design (Digital (co)design)			online learning; and d) blended learning (p. 429).
20. Steinbronn & Merideth (2003)	Quantitative	Social cognitive theory	-Personal resources (Metacognitive regulation, Motivation) - Learning design (Educational roles)	Learning Management System (LMS)	- Teaching (Change of roles) - Learner processes (Learner control, Motivation) - Assessment / feedback (Guidance / support)	The purpose of this article is to present an outward design for online support of a Web-based, summer program that has been implemented at university where student-involved learning is at the heart of the mission, and technology is an important part of the vision of the institucion (p. 17)
21. Suárez, Specht, Prinsen, Kalz & Ternier (2018)	Theoretical	Social cognitive theory	-Personal resources (Learner autonomy, Reflective learning, Metacognitive regulation, Self-regulated learning, Self-directed learning, Motivation) -Participatory resources (Learner control)	Mobile learning	- Learning activities (Inquiry-based learning) - Learner processes (Self-regulation, Self-directed learning, Reflection on learning, Learner control, Learner autonomy, Motivation)	This paper is a literature review that analyzed 62 studies on mobile inquiry-based learning. The analysis focused on the level of agency supported by mobile technology (p. 38).
22. Tan (2014)	Theoretical	Social constructivism	-Personal resources (Ownership of learning, Self-directed learning)	Computer supported Collaborative Learning (CSCL) (Knowledge forum for e-portfolios) Audio creation and editing (podcasts)	- Learning activities (Knowledge building - Learner processes (Ownership of learning, Self-directed learning) - Social relations/roles (Peer support)	The authors present various factors that shape learning in the 21st century (demands of the knowledge-based economy; advances in technologies; and

						changes in perspectives of learning) and present two case examples to illustrate the knowledge creation approach and to compare it with the current approaches (p. 53).
23. Tchounikine (2019)	Theoretical	-	-Personal resources (Learner autonomy, Active learning, Self-regulated learning, Engagement, Motivation) -Participatory resources (Choice making)	Computer supported Collaborative Learning (CSCL)	- Teaching (Personalisation of learning) - Learner processes (Ownership of learning, Logistical choices (technology, place, time), Self-regulation,Learner control, Learner autonomy, Engagement, Motivation) - Assessment / feedback (Personalised feedback, Guidance / support)	This article is a squib that proposes an emancipatory perspective to learners' agency and its technological substratum, and studies the implications of such an approach for research in Computer Supported Collaborative Learning (CSCL). The objective of this study is to shed further light on possible desirable futures for CSCL (p. 237).
24. Townsend (2018)	Mixed methods	-	-Personal resources (Self-directed learning) -Participatory resources (Choice making, Learner control)	Mobile learning	- Learner processes (Logistical choices (technology, place, time), Self-directed learning, Learner control)	This article details the construction of a Grounded Theory to explain the concept of enhancing professional learning through mobile devices (p. 13).
25. Traxler (2010)	Theoretical	-	-Participatory resources (Choice making)	Mobile learning	- Learner processes (Ownership of learning, Ownership of technology, Learner control, Student participation)	This thought piece looks at mobile devices in the hands of so many students and the challenges and

						opportunities that these devices represent for the support and provision of learning, and indeed for the meaning and nature of learning (p. 149).
26. Tsai, Perrotta & Gasevic (2020)	Qualitative	-	-Personal resources (Learner autonomy, Ownership of learning) - Relational resources (Social learning) -Participatory resources (Choice making)	Learning analytics	- Learning Activities (Knowledge building) - Learner processes (Ownership of learning, Self-directed learning, Learner autonomy, Reflection on learning) - Assessment / feedback (Personalised feedback, Guidance / support)	This paper presents a study that explores staff and student experience of agency, equity, and transparency in existing data practices and expectations towards learning analytics in a UK university (p. 554).
27. van Aalst & Chan (2007)	Mixed methods	Social constructivism	-Personal resources (Metacognitive regulation, Ownership of learning, Motivation, Learning to learn) - Learning design (assessment, educational roles)	Computer supported Collaborative Learning (CSCL) (Knowledge Forum)	- Teaching (Change of roles) - Learner processes (Ownership of learning, Self-regulation, Student participation, Motivation) - Assessment / feedback (Assessment of learning)	This article describes the efforts of the authors over several years to design, implement, and improve an assessment approach designed to capture both individual and collective aspects of knowledge building, a specific model of collaborative inquiry (p. 177).
28. Venter (2019)	Qualitative	Theory of the social capital	-Personal resources (Self-regulated learning)	Personal Learning Environments (PLE)	- Learner processes (Self-regulation) - Social relations / roles (Collaborative learning)	This study is directed at exploring the role of social capital development in online learning in view of its challenges (p. 242).

29. Wise & Schwarz (2017)	Theoretical	-	-Personal resources (Learner autonomy) - Relational resources (Sociocultural context)	Computer supported Collaborative Learning (CSCL)	- Learner processes (Learner autonomy) - Assessment / feedback (Guidance / support)	This article is the culmination of a multi-year project to generate a vision of possible futures for CSCL grounded in a critical examination of the past and present. The aim was to take stock of the accomplishments and challenges in the field thus far in order to imagine, probe, and question desirable paths for the future (pp. 424-425).