## 2.3 Method

***Search design***

We conducted an extensive literature review to identify and retrieve empirical studies relevant to answering the research questions. We formulated the following search string, with some variations to take into account for specific retrieval sources: (“blended learn\*” OR “blended instruction\*” OR “blended teach\*” OR “hybrid learning” OR “hybrid instruction\*” OR “hybrid teaching” OR “hybrid course\*” OR “flipped classroom\*” OR "flipped learn\*”) AND (“self-regulat\*” OR selfregulat\* OR SRL OR “self-direct\*” OR “self-manag\*” OR “meta-cognit\*” OR metacognit\*) AND (college\* OR undergrad\* OR "tertiary education" OR “tertiary school\*” OR postsecondary OR “post-secondary” OR universit\* OR “higher education” OR student\* OR freshm\*n OR sophomore\*). We searched the following electronic databases and engines: ERIC, PsycINFO, Web of Science, Scopus and Google Scholar. We used Google Scholar to search for additional sources, but an inspection of the first 200 sources did not yield new publications. The search was limited to peer-reviewed studies in English published from 2000 onwards due to the first use of the term BL in that year (Bliuc et al., 2007). We conducted the search in March 2019.

***Selection process and criteria***

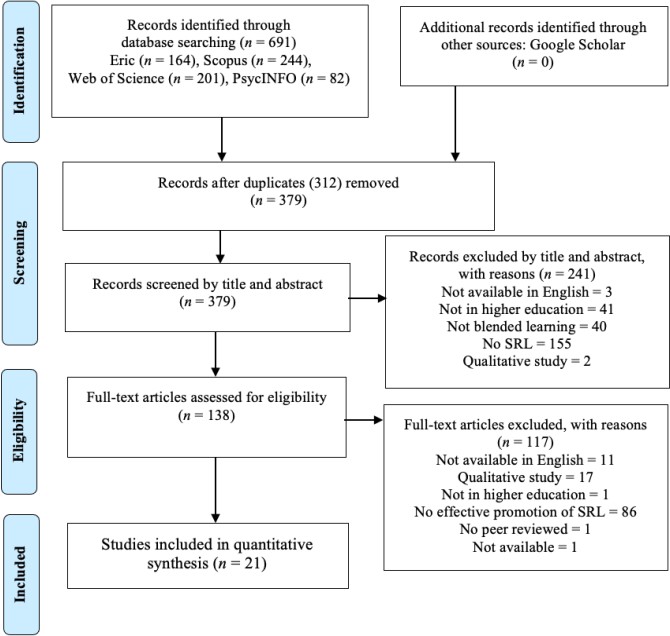
The search resulted in 691 records (see Figure 1). Duplicates (*n* = 312) were identified and removed. Full reports or summaries were obtained for each title that seemed to meet the inclusion criteria (see Table 2).

**Table 2**. *Inclusion criteria*

|  |  |
| --- | --- |
| Criteria | Inclusion |
| Target audience | Higher education |
| Learning environment | BL |
| Studies | Empirical intervention studies focused upon acquiring and promoting SRL  strategies and/or measuring SRL strategies |
| Articles | Peer-reviewed scholarly journals |
| Period | 2000 onwards |
| Language | English |

The first author independently screened titles and abstracts of the remaining manuscripts (*n* = 379) and subsequently examined full texts to determine whether an article was eligible for inclusion. Any doubt about the inclusion was discussed with the other authors until consensus was reached. In total, 241 articles were excluded in view of their titles and abstracts.

Furthermore, 117 full-text articles were excluded for two reasons: (a) the study was not directed to the acquisition or promoting of SRL strategies and (b) it was not a quantitative study. Most studies that were excluded focused only on achieving higher grades, did not examine whether SLR strategies were taught or did not explain how SRL strategies was measured.



**Figure 1**. *Flow diagram of selection of papers (adapted from Moher et al., 2009, p.267)*

***Data analysis***

We developed a coding scheme to systematically analyse the retrieved studies. We tested the scheme and refined it until we agreed on the topics and the corresponding categories. For answering the first research question, we first coded which SRL strategies were addressed in the intervention. Secondly, we coded each study whether the interactional method was human, non-human or a combination of both (Hanna et al., 2000). For answering the second research question, we coded characteristics of the measurement instruments for SRL strategies: name, format (questionnaire, self-report, interview, test with items), type of SRL strategy, psychometric quality (reliability indices and validity). Furthermore, we classified the intervention effects on SRL strategies as reported by the authors, preferably in terms of effect sizes (Cohen’s d).

***SRL strategies in general***

Eight studies investigated SRL strategies in general (4, 5, 9, 11, 12, 14, 16, 19). All studies reported a significant effect, but only three studies (5, 9, 12) reported large effect sizes. Four studies (4, 9, 12, 19) used non-human interactional methods. The non-human student tool featured an online community for questions, discussion, support, sharing and reminders to each other to submit homework (4) or a pedagogical agent that asked students planning, monitoring and evaluation questions (9). One study (19) used the student environment to increase sharing amongst student through the online environment. Study 12 used student content through prompts embedded in videos.

Three studies (5, 14, 16) used a combination of non-human and human interactional methods to foster SRL strategies. The non-human interactional method contained student tools including combining online media with the courses on the platform to facilitate home learning activities (5) and a cloud application to share results with peers and friends (14). Also, student content was provided, for example, prompts from a database to plan, monitor, modify and assess learning tasks (16).

Human interactional methods were applied for repeating the theory and teacher feedback (student-teacher) and peer feedback (student-student) in Study 5; peer feedback on the task (student-student) in Study 14, and metacognitive prompts as means of peer feedback on the task (student-student) and teacher feedback on skills and knowledge (student-teacher) in Study 16. One study (11) promoted SRL strategies in the human student-teacher interactional method through an interactive discussion to stimulate the students to analyse the questions thoroughly.

***Cognitive strategies***

Eight studies investigated cognitive strategies (2, 3, 9, 10, 11, 12, 18, 20), of which two studies studied specific cognitive strategies: rehearsal (2, 11) and elaboration (2). Two studies (11, 18) did not report a significant effect on (general) cognitive strategies. Only three studies reported a moderate (3) or large (9, 12) effect size.

Five studies (9, 10, 12, 18, 20) used non-human interactional methods to promote cognitive strategies: an online pedagogical agent (9) that prompted metacognitive questions in lectures notes and videos (student tool); a discussion forum (10) where students can ask questions and where students and faculty staff can respond to each other to help clarify teaching materials (student tool); prompts (12) embedded in videos (student content); tutorial, quizzes and exams (18) (student content); watching videos and submitting questions (20) to identify gaps in learning (student content).

Three studies (2, 3, 11) used a combination of human and non-human interactional methods: online individual quizzes (2, 3) or questioning via an online discussion forum (11) (student tool) together with team quizzes in class (2) (student-student) and discussions and providing additional information (3, 11) (student-teacher.

**Table 3**. *General characteristics of the studies, by author(s), country, aim of the intervention, participants, cluster, course, research design, core features of treatment and control groups*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Author(s) | Ctry | Aim of the intervention | Participants | Cluster | Course | Research design | Core  features treatment | Control groups |
| 1 | Alsancak Sirakaya & Ozdemir  (2018) | TR | Examine effects of FC model on SDL skills &  motivation | US  (*n* = 66) | SS | RESM | QE-PP | FC  (*n* = 32) | BL  (*n* = 34) |
| 2 | Atwa et al. (2018) | AU | Examine design of novel hybrid pedagogy using team-based & case-based learning to promote self- regulation, engagement & motivation of students with low AU tertiary admission ranks at entry to  university | 1st year (*n* = 314) | S | BDYS | QE-PP | BL & TB & CBL (*n* =75) | 1. TT   (*n* = 75)   1. TT &   no scaffold clinic cases & CBL  (*n* = 164) |
| 3 | Chen & Hwang (2018) | TW | Examine effects of integrated FC & IRS-facilitated collective issue- quest approach on learning performance, self-regulation, collective  efficacy & satisfaction | UG  *(n* = 85) | NM | MKT | QE-PP | FC & IRS-  collective issue- quest strategy (*n* = 42) | FC only (*n* = 43) |
| 4 | Chyr et al. (2017) | TW | Explore effects of online academic help- seeking & FL on improving students’  learning | 1st year (*n* = 102) | SS | OS | QE-PP | 1. FC &   online help- seeking (*n* = 33)   1. FC   (*n* = 34) | TT  (*n* = 35) |
| 5 | El-Senousy & Alquda (2017) | SA | Explore effects of FC strategy using Blackboard mash-up tools in enhancing achievement & SRL skills of  university students | US  (*n* = 60) | S | CMP 101N | E-PP | FC & Blackboar d mash-up sources  (*n* = 30) | TT  (*n* = 30) |
| 6 | Ferrer- Torregros et al. (2016) | ES | Examine didactic strategies & associated DL aids based on FC where transmitting information is via teacher- prepared aids, ensuring students work independently  before class | 1st year (*n* = 171) | SS | MOTF | E-P | 1. FC &   instructor notes & videos  (*n* = 51)   1. FC &   instructor notes & AR  (*n* = 60) | FC & instructo r notes (*n* = 60) |
| 7 | Giacumo & Savenye (2019) | USA | Test effects of two metacognitive scaffolds on cognition by evaluating student critical skill performance in asynchronous  discussion board | UG  (*n* = 257) | SS | LEUP | QE-PP | 1. BL +   instructor prompts   1. BL &   rubric   1. BL   instructor prompts & rubric | BL no rubric & no prompts |

**Table 3**. *(Continued)*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Author(s) | Ctry | Aim of the intervention | Participants | Cluster | Course | Research design | Core  features treatment | Control groups |
|  |  |  | & achievement  in a BL module |  |  |  |  |  |  |
| 8 | Hsu & Hsieh (2014) | TW | Examine influence of | UG  (*n* = 99) | SS | NE | OG-P | BL (2  classes), | - |
|  |  |  | demographic, learning |  |  |  |  | online video & |  |
|  |  |  | involvement & learning |  |  |  |  | exchange through |  |
|  |  |  | performance variables on |  |  |  |  | online chat room |  |
|  |  |  | metacognition of UG nursing |  |  |  |  |  |  |
|  |  |  | students in a BL environment |  |  |  |  |  |  |
| 9 | Karaoğlan Yılmaz et al. | TR | Examine effects of metacognitive | 1st year (*n* =102) | NM | CMP-I | QE-PP | FC & PA  & MS | FC  (*n* = 50) |
|  | (2018) |  | support via pedagogical |  |  |  |  | platform (*n* = 52) |  |
|  |  |  | agent on students’ self- |  |  |  |  |  |  |
| 10 | Kassab et al. | IE | regulation skills Examine the | 2nd year | SS | JCM | OG-P | BL & | - |
|  | (2015) |  | relationship between aspects | (*n* =171) |  |  |  | virtual learning |  |
|  |  |  | of course experience, SRL, |  |  |  |  | (*n* = 171) |  |
|  |  |  | & academic achievement of |  |  |  |  |  |  |
|  |  |  | medical students in a BL |  |  |  |  |  |  |
| 11 | Ma et al. | CN | curriculum Assess students’ | 2nd year | SS | MI | QE-PP | APP-FC | TT |
|  | (2018) |  | perceptions of application-based | (*n* = 92) |  |  |  | & mobile phone app | (*n* = 50) |
|  |  |  | FC teaching model in an |  |  |  |  | (*n* = 42) |  |
|  |  |  | immunology course |  |  |  |  |  |  |
| 12 | Moos & Bonde (2016) | USA | Examine effectiveness of | UG  (*n* = 32) | SS | PSY | QE-PP | FC & video & | FC & video |
|  |  |  | embedding SRL prompts in a |  |  |  |  | SRL  prompts | (*n* = 16) |
|  |  |  | video designed for FC model |  |  |  |  | (*n* = 16) |  |
| 13 | Ng (2018) | CN | Examine whether FC with | 1st year (*n* = 73) | SS | IT | OG-PP | FC & SRL | - |
|  |  |  | reference to SRL principles is a |  |  |  |  | principles (two |  |
|  |  |  | good pedagogy for enhancing |  |  |  |  | classes:  *n*1 = 38, |  |
|  |  |  | formative learning |  |  |  |  | *n*2 = 36) |  |
|  |  |  | outcomes for first-year US |  |  |  |  |  |  |
| 14 | Ozdamli (2013) | TR | Analyse conditions | US  (*n* = 40) | SS | LM | QE-PP | BL & MSSS & | - |
|  |  |  | affecting students’ |  |  |  |  | Evernote & social |  |
|  |  |  | perceptions of self-directed |  |  |  |  | network applicatio |  |
|  |  |  | abilities & seamless |  |  |  |  | n  (*n* = 40) |  |
|  |  |  | learning using cloud systems & |  |  |  |  |  |  |
| 15 | Samruayruen | TH | social network applications Examine | UG/GD | NM | NM | OG-P | BL & | - |
|  | et al. (2013) |  | relationship between | (*n* = 88) |  |  |  | online courses |  |
|  |  |  | motivation & learning |  |  |  |  | (*n* = 88) |  |
|  |  |  | strategies sections & |  |  |  |  |  |  |

relationship

**Table 3**. *(Continued)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Author(s) | Ctry | Aim of the intervention | Participants | Cluster | Course | Research design | Core  features treatment | Control groups |  |
|  |  |  | between learners  demographic |  |  |  |  |  |  |  |
|  |  |  | information & SRL |  |  |  |  |  |  |  |
| 16 | Shyr & Chen (2018) | TW | Examine whether a technology- | 2nd year (*n* = 81) | S | EN | QE-PP | Flip2Lear n & FC | FC  (*n* = 44) |  |
|  |  |  | enhanced flipped language system |  |  |  |  | (*n* = 40) |  |  |
|  |  |  | (Flip2Learn) enhances college |  |  |  |  |  |  |  |
|  |  |  | students’ SRL skills & |  |  |  |  |  |  |  |
|  |  |  | contributes to learning |  |  |  |  |  |  |  |
| 17 | Silva et al. | BR | performance Analyse effects | US | S | MOM | QE-PP | FC & | FC |  |
|  | (2018) |  | of learning analytics on | *(n* = 96) |  |  |  | feedback bulletin | (*n* = 45) |  |
|  |  |  | students’ SRL in FC |  |  |  |  | per learning |  |  |
| 18 | Tempelaar et | NL | Examine whether | 1st year | SS | MAS | OG-PP | unit  (*n* = 51)  FC | - |  |
|  | al. (2018) |  | combination of | (*n* = 1027) |  |  |  | (*n* = 1027) |  |  |
|  |  |  | trace data derived from |  |  |  |  |  |  |  |
|  |  |  | technology- enhanced |  |  |  |  |  |  |  |
|  |  |  | learning environments |  |  |  |  |  |  |  |
|  |  |  | and self-response survey |  |  |  |  |  |  |  |
|  |  |  | contributes to investigation of |  |  |  |  |  |  |  |
| 19 | Uz & Uzun | TR | SRL processes Examine | UG | S | PL | QE-PP | BL (*n* = | 2xTT, |  |
|  | (2018) |  | influence of BL environments on | (*n* = 167) |  |  |  | 60)  In-class: | (*n* = 65,  42) |  |
|  |  |  | students’ SRL & SDL skills |  |  |  |  | direct instructio |  |  |
|  |  |  |  |  |  |  |  | n,  Pre-class: |  |  |
|  |  |  |  |  |  |  |  | individual activities |  |  |
| 20 | van Vliet et al. (2015) | NL | Examine effects of FC on | 2nd year (*n* = 170) | SS | PBIO | OG-PP | FC, 2  Course 1: | - |  |
|  |  |  | motivation & learning |  |  |  |  | TT  Course 2: |  |  |
|  |  |  | strategies in higher education |  |  |  |  | TT and FC |  |  |
| 21 | Zhang et al. (2019) | CN | Examine effects of rubric use in | US  (*n* = 83) | NM | RES | E-PP | FC  rubrics in | FC  rubrics |  |
|  |  |  | FL activities on students’ |  |  |  |  | pre-class activities | in pre- class: |  |
|  |  |  | learning achievement, |  |  |  |  | (*n* = 36) | review, modify |  |
|  |  |  | metacognitive awareness & |  |  |  |  |  | finished work |  |
|  |  |  | cognitive load |  |  |  |  |  | (*n* = 47) |  |

*Note.* FC = flipped classroom; FL = flipped learning; BL = blended learning; DL = distance learning; TT = traditional teaching; NM = not mentioned; - = not applicable.

Ctry: Country: AU = Australia; BR = Brazil; CN = China; IE = Ireland; NL = Netherlands; ES = Spain; SA = Saudi Arabia; TH = Thailand; TW = Taiwan; TR = Turkey; USA = United States of America.

Participants: US = university students; UG = undergraduate; GR = graduate. Cluster: S = Science; SS = Social science.

Course: RESM = Research Methods; BDSYS = Body System; MKT = Marketing; OS = Office Software; CMP = Computing; MOTF = Muscle of the Foot; LEUP = Legal & Ethical Use of Property; NE = Nursing Ethics; JCM = Junior Cycle Medical; MI = Medical Immunology; PSY = Psychology; IT = Information Technology; LM = Learning Methods; EN = English; MOM = Mechanics of Materials; MAS = Mathematics & Statistics; PL = Programming Languages; PBIO = Psycho Biology; RES = Research.

Research design: QE-PP = quasi-experiment pre-postttest; OG-P = one-group post only; OG-PP = one-group pre-posttest; E-P= experiment posttest only; E-PP = experiment pre-posttest.

Core features treatment: MSSLS = mobile supported seamless learning space; AR = augmented reality