Do learning technologies contribute to reduce student drop-out? - A systematic review

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As technology is increasingly being used for teaching and learning in higher education, it is important to examine what tangible educational gains are being achieved. Reducing drop-out rates have been proposed as one possible beneficial effect of the use of learning technologies. It is unclear, however, whether the available evidence supports such claims. The aim of this study was to explore whether learning technologies applied in higher education contexts can contribute to reduce student drop-out rates, and under which circumstances do learning technologies influence drop-out? Method: Two independent searches were conducted in relevant databases; evaluated full-texts, quality rated the included studies, and synthesized the findings. Results: A total of 18 peer-reviewed studies were included. Based on the quality assessment, 10 studies were eligible to extended data synthesis. The assertion that learning technologies in higher education contribute to reduce student drop-out is only partly supported. Positive findings were in particular found in relation to pedagogical issues, e.g., individualized personal support. This is in line with previous research, indicating that it is not the technology itself, but how the technology is used pedagogically that matter to students.

Keywords: Learning technologies; Educational IT; Drop-out, Retention; Systematic review; Higher education

Background

Learning technologies have been introduced in university strategies and policies, and numerous initiatives have been implemented with the aim of creating more active and varied teaching and assessment methods (Lillejord et al. 2018) that provide students with more flexible and engaging learning environments (Kirkwood and Price, 2013). Helping students to engage in learning, the use of technology has been proposed as a means to reduce student attrition, and many expectations regarding how learning technology may improve teaching and learning have been articulated (Fossland 2015, p.8). It is unclear, however, to which degree the available evidence supports such claims. Kirkwood and Price (2013) argue that many general characterizations of technology-enhancement in education are unclear and often limited to the use of technology in itself. Claims regarding the benefits and effectiveness of educational technologies need further exploration. The aim of the present study was to explore:

Whether – and under which circumstances - learning technologies applied in higher education contexts can contribute to reducing student drop-out rates?

Materials and Method

Data sources and search strategy

Based on Littell, Corcoran & Pillai's (2008) guidelines for systematic reviews and meta-analysis the initial keyword-based search was conducted independently in October 2017 by second author and a university librarian for relevant empirical peer-reviewed studies published between 2007 and 2017. Databases included for this review were EBSCO HOST: ERIC (The Education Resource Information Center), CINAHL (Cumulative Index to Nursing and Allied Health Literature), British Education Index, Education Research Complete, Communication & Mass Media Complete, ProQuest: Australian Education Index, Education Database, PsycInfo, Web of Science: Social Science Citation Index, Scopus. The final search string consisted of combinations of subject headings Higher education and keywords referring to retention OR attrition OR drop-out OR turnover OR "at risk" "blended learning" OR "computer assisted instruction" OR "computer managed instruction" OR "courseware" OR "distance education" OR "electronic learning" OR "integrated learning systems" OR "intelligent tutoring systems" OR "online courses" OR "mobile learning" OR "virtual classrooms" OR "web based Instruction" OR "technology mediated" OR "online learning" OR "Educational IT" OR "technology enhanced learning" OR "technology supported learning" OR "Hybrid learning" OR "technology". To ensure a certain timeliness in

relation to the technologies used in the studies, 2007 was chosen as our point of departure. All studies were screened independently by the use of Covidence according to our inclusion and exclusion criteria.

Only studies in relation to BA or MA- degree programs and courses which included use of technology in relation to reduce student drop-out were included. Disagreements were discussed until a negotiated conclusion was reached. The review included studies across geographical settings published in peer-reviewed English language journals.

Quality assessment

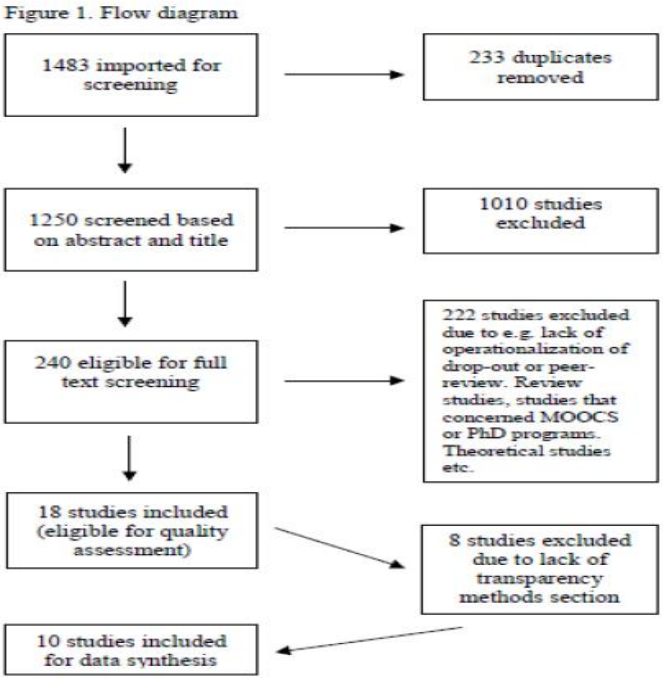
All studies included were subjected to a quality assessment by two independent raters based on a 20-item quality assessment tool for quantitative research studies based on work by Mager & Nowak (2012) Savin-Baden & Major (2010) and Tong, Sainsbury, & Craig (2007). Variations among studies, strengths and weaknesses of the research in relation to issues of validity, reliability, clarity in research question, transparency in the research method and the research design, and whether there is alignment between the research question and the study`s findings was identified (Cohen & Crabtree, 2008). Each quality criterion was assigned 0-2 point, yielding a total study quality score of 0–40 points with higher scores indicating higher study quality. Discrepancies between the authors were resolved during a process of consensus rating as recommended by Littell et al. (2008). Studies receiving at least 30 points, and of which at least 8 points must be obtained in "methods" were included in a subsequent data synthesis.

Data were extracted from all of the included articles (e.g., details of the contextual background e.g. discipline, study level, teaching format etc., definition and operationalization of retention, research design e.g. qualitative or quantitative, and key findings).

Results

The search of the electronic databases yielded 1483 hits. 18 studies were quality assessed. Study quality ranged from 9-40 points. Ten studies were found eligible for the final data synthesis (illustrated in Figure 1)

Figure 1. Flow diagram



The included studies were published between 2007 and 2017, with the majority of studies from the USA (n=8) and fewer from UK (n=1) and Australia (n=1). The definition of drop-out varied in the included studies, e.g. 1) the proportion of students who did not complete full courses or modules in a course (e.g. Liu & Stengel, 2011), 2) the proportion of students who obtain the grades lower than "C" (Wladis et al., 2017; Xu & Jaggars, 2011) or

3) the proportion of students who did not pass the exam criteria (e.g. Ashby et al, 2011). The majority of the studies were related to drop-out among BA-students (illustrated in table 1).

Table 1. Overview of studies included in the data synthesis

Study **Year** **Country**	**Disciplin** **Study level** **Participants (N)** **Age (Avg.)** **Gender**	**Course formats**	**Research design** **Definition of drop-out**	**Results**
Ashby, Sadera & McNary (2011) USA	Algebra, BA N= 167 Female: 58% Age: 25,5	3 formats: OO (38%) F2F (35 %.) Lectures and take home tests BL (28%)	Quantitative Exam Participation Pass: ≥ 70% Ongoing testing in all formats	Passed-score: F2F: 63% BL: 69% O: 85% recommended for exam: F2F: 93% BL: 70% O: 76%
Garratt-Reed, Roberts & Heritage*	Psychology, BA N = 866 Age: N / A Gender: N/A	Comparisons of two formats TECH: (n= 810) Lectures, group discussions, lecture recordings, written assignments OO: (n=56). video lectures, reflection diary, open and closed discussion groups, written submissions	Comparison/ Quasi experimental Mixed method (administrative data, SET, Compulsory assignments and grades Pass/ fail. Final grade, SET	Pass / fail F2F: passed: 96% O: passed: 91% SCORES: F2F Students achieved significantly higher exam scores compared to OO students
Griff & Matter (2013) USA	Anatomy and Physiology, BA N = 587 Age: N/A Gender: N/A	Comparison of two TECH formats TECH (Experiment) (n = 264) Adaptive learning system TECH (Control)Online quiz (n=323)	Experiment with control group Pre-test: 25 questions for all participants Post-test scores Dropout rate: number of admitted students / number of students who completed	Pre-test: No significant difference between. The two groups Average scores <50% Post-test: No significant difference between the two groups Dropout: No significant difference
Hughes (2007) UK	Pedagogy, BA n = 65 n = 254 (f2f control group) Age: N/A Gender: N/A	BL (experiment) 30% of the lectures were replaced with online tutoring and activities for the students. Special counseling, primarily online, for drop-out students 1st time (n = 15) 2nd time (n = 30)	Action research: BL course is tested twice and compared to the previous blended version of the course and similar f2f courses Log books. (weekly) Administrative data Non-attendance (not completed the course /	L courses with special support for students at risk had the lowest dropout rates (6% and 17% respectively) compared to dropouts in F2F courses (25% - 55%) and dropouts in BL courses without special support (25%).

		BL (pre-intervention) (n = 20) F2F (control group) (n = 254)	assignments, including interventions: online participation	
Liu & Stengel* (2011) USA	Statistics (n = 134) Quantitative Analysis (n = 129), BA Age: N/A Gender: N/A	Comparison of two formats: TECH .: Lectures with IClicker. Weekly online quiz (n = 58 + 67) F2F: Lectures, task solving without clickers. Weekly online quiz (n = 76 + 62)	Comparative experiment / Quantitatively Course completion Average performance during tests	Completion in Statistics course: TEK: 87.9% of the initially enrolled (n = 58) completed the course F2F: 69.7% of the initially enrolled (n = 76) completed the course Completion in Quantitative analysis Course: TEK: 80.6% of the initially enrolled (n = 67) completed the course F2F: 56.5% of the initially enrolled (n = 62) completed the course
Pittenger & Doering* (2010) USA	Farmaci BA og MA N = 1461 Average age: N/A Gender: N/A	Self-study (OO) with ongoing assessment, instructor feedback and weekly emails	Comparative / longitudinal (same 4 courses over 2 semesters) Mixed method (administrative data & questionnaires: IMMS and ARCS-based questionnaire Course completion Grades and increased motivation, Attention Relevance, Trust, and Satisfaction	Completion for the four courses: ≥ 95%. The primary factors that motivate students: well organized course structure with weekly emails, high quality learning material and relevance as well as flexibility and suggestions
Powers et al. (2016) USA	Psychology, BA n=730 Age: N/A Gender: N/A	Comparison of two formats: F2F: Videos and simulations, lectures and discussions BL: Once a week. The remaining time (equivalent to 30% of the original teaching time) is allocated to online exercises online in MyPsychLab and LMS	Quasi-experimental To compare learning outcomes across BL and F2F formats, the relationship between online homework and exam grades in the blended courses, as well as examining teacher and student preferences for delivery formats. Drop-out upon cancellation of the course	No significant difference in dropout rate in the two course formats Dropout rate: BL: 16.8% F2F: 14.8%. Primary reason for choosing the hybrid course: flexibility

Robb & Sutton* (2014) USA	Discipline = N/A, BA n = 388 Age: N/A Gender: N/A	Students in the experimental group (OO) received five motivational emails from the teacher during the course	Randomized experiment with control group (one semester, 12 courses) Quantitative data. Questionnaire regarding motivation (Course Interest Survey) Completion of course and final grade (≥C	Experiment group (n = 191) 58.6% of the group receiving motivational emails completed the online course, while 47.2% in the control group (n = 197) completed Students who received emails obtained significantly higher grades than students in the control group did.
Wladis, Conway & Hachey* (2017) USA	Business economics, Nursing, Rhetoric, Language, Social Sciences, Mathematics, Computer science, Sports, BA (n = 2330) Age: N A Gender: N/A	Comparison of two formats: OO/BL (n = 1001), F2F (n = 1329) 21 different courses (all courses offered in the same semester by the same teacher, respectively)	Quantitative Longitudinal (2004-2010) Completion of course with grade = ≥ C Independent variables: STEM vs. not STEM Mandatory, optional, 'distributional', severity (Lower level, Upper Level)	Lower level courses: Higher course completion O (49.9%) than F2F (42.2%) Upper level courses: Higher course completion F2F (77.8%) than O (73.7%) Avg. completion of courses: O = 58.6% F2F = 65.3% Significantly higher drop-out rate at optional OO-format courses as opposed to compulsory O-format courses
Xu & Jaggars* (2011) USA	English and Mathematics. Admission process n = 24,000, 23 universities Age: N/A Gender: N/A	Comparison of two formats F2F: Specifications not described. OO: Developed locally. Specifications not described	Register data, Longitudinal (4 years) Pre-exam drop-out (course fee paid) and grade at final exam (≥C)	

Themes

Comparisons of teaching formats

This review includes four studies that investigate whether the teaching format affects dropouts.
The teaching formats investigated were a) face to face (F2F) (no tech), b) blended teaching (BL), i.e., F2F & online, c) F2F complemented by online activities in class (TECH.), and d) online only (OO). In a study of 167 Algebra students, Ashby and colleagues (2011) compared three teaching formats: F2F, BL, and OO, and found no statistically significant differences in relation to the number of students who passed the exam. In a study of 866 Psychology students, Garratt-Reed and colleagues (2016) compared OO with a TECH format in relation to drop-out, grades and Students evaluation of teaching (overall outcome) and found that significantly more students

passed the TECH course (96%) than the OO course (91%). Using registry data on approximately 24.000 students, Xu & Jaggars (2011) compared dropout rates in F2F and OO introductory courses in English and Mathematics in 23 different HE institutions and found that the dropout rates were significantly higher among students participating in OO courses. In English and Mathematics, the dropout rates among OO-course participants were 19% and 25% respectively, compared to 10% and 12% among F2F course participants. The authors argue that the differences were primarily due to between-course differences in student characteristics rather than the delivery format. In a study of 2330 students, Wladis and colleagues (2017) explored whether particular delivery formats (F2F, BL, OO) were more suitable for specific course types than others, e.g., depending on academic discipline (STEM vs. non-STEM), whether they were optional or compulsory, and lower vs. upper level. Identical courses were offered in the different formats by the same teacher in the same semester, and repeated over a number of years (2004-2010). The results indicated that dropout were lower in the F2F format (65.3%) compared to the OO and BL formats (58.6%), but that there were significant distinctions. In optional online courses, drop-out were significantly higher compared to the compulsory online courses. In addition, students were more likely to complete a lower level online course (49.9%) than F2F (42.2%), while the opposite results were seen for upper level courses. For both F2F and BL/OO, the average course performance was generally better for upper level courses compared to lower level courses.

Due to the variability in the four studies, and a general lack of information on contextual matters, and knowledge about students' perception of the various teaching formats, the available evidence does not allow for clear conclusions regarding the association between delivery format and drop-out.

Comparison of teaching interventions

Six studies compared different teaching interventions aimed at increasing either student performance, motivation and/or active engagement. The interplay between content, technology, and pedagogy was thoughtfully considered in these studies, e.g. how various digital resources were used to solve specific learning tasks and/or challenges and how this influences student's learning. Of these six studies, four studies found a positive correlation between lower dropout rates and using learning technology.

Liu & Stengel (2011) compared TECH vs F2F in two different course modules, a) Statistics and b) Quantitative methods (n=263). They examined whether teaching involving use of clickers to answer multiple choice questions followed up by discussions with the teacher lead to an increase in the students' interest in the subject, a better performance, and reduced drop-out rates, when compared with teaching without clickers and feedback on the assignments during class. The results indicated that the completion rate was higher in the course modules where clickers were used (Course A: TECH. 87.9% vs 69.7%; Course B: 80.6% vs 56.5%).

Two studies were concerned with adaptive learning utilizing technology to deliver customized resources and learning activities to address the unique needs of each learner. The two studies revealed no associations between the technology used and drop-out. The study by Griff and Matters (2013) compared dropout in two groups, a) Anatomy and b) Physiology (n= 587); one in which the online assignments continuously matched the student's individual proficiency level and progression, and a control group which received assignments from a question bank selected by the instructor. Students in both groups increased their knowledge and no statistically significant differences were found in performance or dropout (mean difference: 7.6%). Powers and colleagues (2016) investigated drop-out rates among Psychology students (n=730) participating in two different teaching formats - a F2F and a BL course which included an adaptive learning element (MyPsychLab). The two courses ran in parallel, and the groups reviewed the same academic content. No significant differences in dropout rates between the two groups (F2F: 14.8 % vs BL: 16.8%) were found.

Three studies focused on motivational instruction and course designs to promote students' sense of belonging. The results of these studies revealed that even seemingly minor activities, e.g., sending encouraging e-mails, could contribute to reducing drop-outs. Robb & Sutton (2014) compared two groups of students (discipline not stated) in an online course. Group A (n= 191) received five motivational, non-personalized emails covering counseling on progression, reminders to review feedback, recognition of work performance, and encouragements to complete the course. Group B (n=197) received no e-mails but had access to the same information on a course platform. The drop-out rate was lower among students who received emails (41.4%) compared with those who did not (52.8%). Pittenger & Doering (2010) examined 1462 Pharmacology students' experience of online courses, which already were characterized by high completion rates (≥ 95%). A comparative analysis of four courses (administrative data & questionnaires) suggest that dropout rates are lower in courses with the following characteristics: well-organized course structure, weekly e-mails with suggestions for participation in the course activities and tasks, learning activities focusing on active learning, and flexibility in relation to carrying out tasks.

Hughes (2007) investigated a BL course program with 319 participating Early Childhood Education & Preschool Teaching students. Thirty percent of the lectures were converted to online activities and online guidance for students at risk for dropping out. The teacher monitored student activities via a learning management system, and special guidance (of administrative, technical, motivational or academic nature) was offered to students who were less active. The results indicated that the combination of proactive help and encouraging communication increased the number of students completing the course compared with a previous version of the BL course without support.

Summary and conclusion

Students at risk of dropping out appear to need more attention and tutoring, and opportunities for feedback appear to be essential. While teachers can provide this, it is challenging in classes with many students. To meet such challenges, technology is increasingly used as a remedial approach to improve students' motivation to learn and maintain their interest on the subject and/or provide a flexibility that allows students to focus more on the content they may have failed in and thereby reduce drop-outs. As an example, learning management systems can be used to identify areas in need of improvement and to facilitate improved teacher-student interactions, thereby assisting students in completing a course successfully (Lillejord, et.al. 2018). It is unclear, however, whether the available evidence supports such claims. The goal for the present review was to contribute to closing this knowledge gap. This was done by reviewing a segment of more recent empirical research. We asked whether – and under which circumstances - learning technologies applied in higher education contexts could contribute to reducing student drop-out rates.

Based on the studies synthesized, we are not able to identify an unambiguously positive correlation between the use of technology and lower dropout rates. Simply making teaching technology facilitated does not per se reduce dropout rates. Studies indicating a positive correlation between lower dropout rates and technology-based teaching mainly report on initiatives, in which learning technologies support teaching interventions aiming at activating and motivating students. We found it particularly interesting, that with even a relatively small effort, teachers appear to be able to influence student engagement and ultimately reduce student dropout as shown in Robb & Sutton (2014) and Pittenger & Doering (2010) studies. Here, the evidence suggested that minor initiatives, e.g., sending motivating emails to students to promote students' sense of belonging or using classroom responsive systems to posit questions and ask students to reflect on their response, and then discuss with their teacher, were effective tools to improve academic performance and reduce dropout. However, the generalizability of the findings may be limited due to the relatively small number of available studies.

Based on our findings, we recommend that higher education degree programmes focus on three aspects in terms of integrating technology in order to reduce dropout rates: Firstly, students should work actively and together; there should be interaction between teachers and students. Learning technologies can support such initiatives. Secondly, our study shows a positive correlation between regular motivational and guidance communication concerning the requirements of the course on the one hand, and student progression on the other. For example, one of the studies included in our review showed that the use of automatic emails with motivational messages, instructions and reminders from teachers to students resulted in significantly lower dropout rates compared with the dropout rates for students who did not receive these emails. Teachers can easily access such a tool. Thirdly, as the implementation of educational technology is often a top-down process rather than a result of teachers' demands, technology-enhanced learning is frequently also technology-focused (Damsa et al. 2015). Programs with the aim of promoting use of technology in teaching should therefore be aware of not only focus on technical training but also on motivating teachers to reflect on how technologies are implemented in relation to the course context and on the value of interaction with and between the students online. We found that scholarly approaches were rarely used when implementing technology in teaching. Several of the reviewed studies lacked pedagogical reflections regarding how technologies are implemented in relation to course contextual matters, and student factors that also may influence the learning process (see for example Biggs & Tang, 2011; Ellis & Goodyear, 2010; van Dinther, Dochy & Segers, 2011). Kirkwood & Price (2013) argue that teachers must reflect upon how technology interacts with approaches to teaching, and that pedagogy must guide the use of technology in teaching, rather than the other way round. Lillejord and colleagues (2018) note that despite much talk about the potential of technology to transform teaching and learning in higher education, teachers need to focus not only on the technical functions of on-line materials and activities but also seek to understand their students' perceptions of this aspect of the learning environment, and how successful it is in supporting student learning across a course.

Strength and limitations

The strengths of the present systematic review include a comprehensive selection process with independent literature searches, study selections, and quality assessments. We have synthesized the results, hoping that researchers, educational developers, and teachers will apply the knowledge in their own work. Some limitations should also be noted. First, the small number of available studies may limit the generalizability of the results. Second, our search strategy for this study was relatively narrow. Although language restrictions are not ideal, we chose to limit our search to studies published in English-language peer-reviewed journals, thereby possibly limiting the scope of this study. On a related note, we did not include the "grey literature", e.g., dissertations, conference abstracts. The search for grey literature is a less systematic process and grey literature studies are often of lower methodological quality, thereby risking compromising the validity of our findings.

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