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ACQUISITION OF PSYCHOMOTOR SKILLS IN AN ONLINE OR HYBRID CLASSROOM: A SYSTEMATIC REVIEW

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ABSTRACT

Objective: During the COVID 19 pandemic, schools across the world have had to adapt their curricula to allow students to continue their education remotely or via hybrid classroom format. The effectiveness of online/hybrid teaching has been studied with respect to many academic skills. However, the effectiveness of this type of teaching on psychomotor skills has not yet been determined. The purpose of this systematic review was to compare healthcare students' acquisition of psychomotor skills in an online format versus traditional classroom format.

Methods: Researchers reviewed over 100 articles using Cochrane Library, CINAHL, PubMed, and Google Scholar databases and search engines. This review included studies that involved healthcare students, remote or hybrid curriculum design (experimental group), traditional face-to-face curriculum design (control group), and analyzed the effects the respective teaching methods had on acquisition of psychomotor skills. After screening and removal of duplicates researchers were left with 10 articles that were included in this systematic review. Studies used were analyzed by sample size, population, measure description, JBI score, and the findings of each study.

Results: The JBI critical appraisal tool for quasi-experimental studies was utilized for this systematic review. All researchers appraised the ten articles.

Conclusion. Although the number of studies in this area are limited, researchers expect the volume of studies to increase in the near future due to the shift in educational techniques during the COVID-19 pandemic. The majority of studies in this review

support online education alone or as a supplement to traditional face-to-face education as an effective way to teach psychomotor skills.

Impact Statement. The results of this review show potential for greater application of online or hybrid learning for the acquisition of psychomotor skills, potentially increasing accessibility to education for students at all times, including during situations when in-person education cannot take place.

INTRODUCTION

In March 2020, the norms of everyday life in the United States ground to a halt in the wake of the rapid spread of the novel coronavirus. COVID-19 created uncertainty in all facets of life, demanding rapid adaptation and constant flexibility. Nearly all educational institutions, from preschool to graduate level education, had to adapt to a new format of learning: online learning. In Fall 2020, 71% of graduate students were enrolled in at least one online learning course, with 52% enrolled in exclusively online learning courses.[1] Several studies sought to identify the challenges and benefits of this new method of learning. One qualitative study titled “Finding My Own Way” analyzed the responses of nursing students and the stresses they faced during the COVID-19 pandemic, highlighting the difficulties of this transition.[2] Researchers found that these nursing students found added difficulty in adapting to this new format along with handling the stress of a global pandemic. Ultimately, the researchers determined that understanding the feelings of students would better help educate future classes over the internet. The general opinions and views of these nursing students are certainly not unique to that profession.

Most healthcare professionals require a sophisticated knowledge of physical skills in patient handling. These skills have been previously taught exclusively through a face-to-face (F2F) learning environment, but the COVID-19 pandemic forced many to resort to online or hybrid learning formats. Due to the sudden dependence on online learning, researchers aimed to examine the effectiveness of online-only or hybrid learning as an appropriate tool for improving psychomotor skills when compared to F2F learning.

Previous research has shown that an online learning format can be beneficial in healthcare education.[3,4] Online learning has been proven to be at least as effective, if not moreso, in healthcare education as the F2F learning format for written exam performance.[3,4] This is important because online learning allows students to reduce time and costs associated with commuting to and from school. Because of this, the online format gives healthcare education a further, more equitable reach to rural communities.[5] This could help to improve healthcare inequities by creating a more inclusive learning environment. With the advances in accessibility and comfort, while also encouraging student-centered learning, online and hybrid learning formats are likely to become significantly more common in healthcare education.[6] One study showed that roughly 65% of medical school faculty were in favor of adding online components to their teaching.[7] With this online format gaining more popularity, it is important to investigate the effectiveness of online learning as a valid substitute for or supplement to traditional, F2F learning. This systematic review sought to determine whether hybrid learning was as effective as traditional learning, specifically for acquisition of psychomotor skills in healthcare students.

METHODS

Data Sources and Searches

Searches for publications were conducted using the Cochrane Library, CINAHL, PubMed, and Google Scholar. Search terms included *hybrid learning, online learning, virtual learning, distance learning, e-learning, traditional, face-to-face, psychomotor,*

manual, and *palpation.* A date range from 2012-2022 was used to further refine searches done on PubMed and Google Scholar. Copies of returned studies were accessed via online journals.

Study Selection

Articles included in this systematic review were limited to experimental and quasi-experimental designs. Inclusion criteria consisted of articles whose subjects were students learning with hybrid, online, virtual, distance, e-learning, or F2F learning methods. Outcome measures for these studies included examination in psychomotor, manual, or palpation skills. The exclusion criteria consisted of articles that were not published in (or translated to) English, not published in peer-reviewed journals, did not analyze hands-on skills, or did not have a standardized assessment criteria for psychomotor skills. Researchers selected studies that examined adult students in healthcare related programs. Researchers included studies examining the effect of multiple variations of online learning including 100% online learning as well as hybrid or blended learning, in which some instruction was done in person and some was done online. Researchers originally aimed to only include studies in which online learning was compared directly to traditional F2F learning, but due to lack of studies with this comparison, researchers included studies that lacked this comparison group.

Data Extraction and Quality Assessment

Articles were selected for more detailed review and appraisal based on article title, abstract, keywords, and full text. A summary of selected articles can be found in Table

1. Selected articles were reviewed in detail and appraised individually by each member of the research team and again as a group, where any discrepancies were resolved through discussion. Study quality and risk of bias was evaluated using the JBI Critical Appraisal Checklist for quasi-experimental studies (Table 2).

Data Synthesis and Analysis

The data were compiled into Table 1. Sample sizes and descriptions of the various skill measurements were explained in the table. Because there are no uniform ways to test for skill expertise, this required a more in-depth description. Critical appraisal scores for each article were compiled, with the corresponding JBI scores listed. General findings of each study were described in the second-to-last column and miscellaneous comments were added for most articles, as needed to describe varying research methods.

Role of the Funding Source

There are no funding sources to disclose for this review.

RESULTS

The Cochrane library search returned 21 results. Nineteen were removed for not meeting the inclusion criteria and one duplicate was removed, with one study remaining and no similar systematic reviews found. The CINAHL search returned 41 results, of which 32 were removed for not meeting inclusion criteria. Six additional studies were removed because they were duplicates, leaving 3 total studies remaining. Researchers

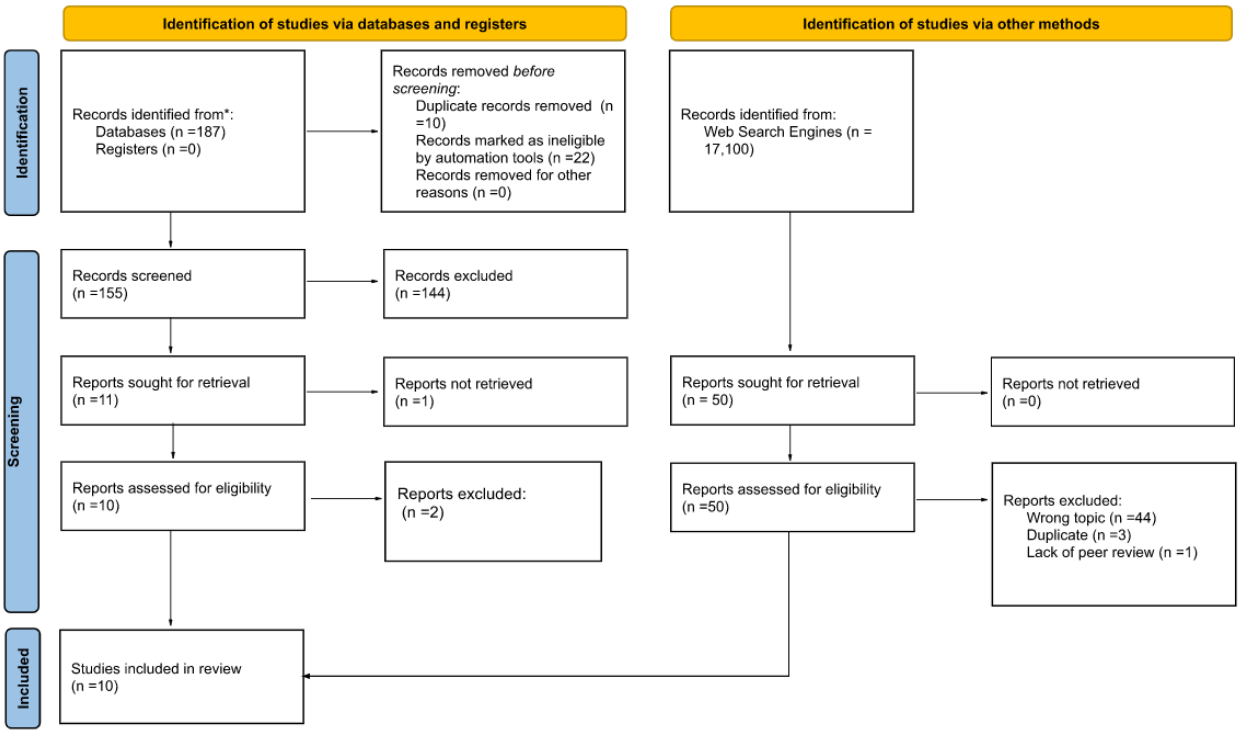
were initially unable to access two of these. Attempts to contact authors returned only one article with no other correspondence from the other. Two searches on PubMed returned a total of 103 results. Of these, 94 were removed due to not meeting inclusion criteria and 3 duplicates were removed with 6 total studies remaining. The Google Scholar search returned 17,100 results. Articles were then sorted by relevance (by Google Scholar automated rankings) and the first 50 results were reviewed. Of these, 44 were removed due to not meeting inclusion criteria. Three duplicates were removed, with 3 total studies remaining.

In total, 12 articles were reviewed in detail. One was removed after finding that it was not yet peer reviewed. One was removed due to being a near duplicate of another paper with the same authors. Ten articles were included in the final appraisal process and systematic review. Figure 1 provides a visual representation of this process.

Critical appraisal of the publications revealed generally strong methodology in the publications selected for this review with all studies using appropriate outcome measures, appropriate statistical measures, measuring results in the same way between groups, completing a follow up, and clearly identifying the cause and effect for each study. However half of the studies included [9-10,12-13,16], lacked a F2F only control group and instead used online education as a supplement to the traditional F2F education that both groups received. There were also several studies [9,11-13,15] that did not state clearly if the participants used in the study were similar. Aside from these two major weaknesses all studies included scored at least 7/9 on the JBI tool used which allowed us to confidently include them in this review.

Table 1 provides a summary of the articles included in this review including sample size, population studied, outcome description, JBI score, and significant findings. All studies examined adult healthcare students, including community college students, undergraduate students, and mixed groups of healthcare students learning and being evaluated on specific skills. Measurement of psychomotor skills was most often performed via in-person practical examination, with one study using video recordings of students' clinical skills. Findings among studies generally supported the incorporation of online learning methods as at least as effective as traditional methods. [8-13, 15-17] One study supported F2F teaching methods over online methods.[14] Two studies showed no additional benefit to supplemental e-learning. [15, 17]

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) 2020 flow diagram.



DISCUSSION

This review aimed to identify whether a fully online or hybrid learning environment provided instruction of psychomotor skills that was comparable to a traditional fully in-person education setting. As evidence-based practice continues to be the standard in healthcare, education of future healthcare workers must also remain evidence based. Previously, computer-based learning software was introduced with little evidence to back up its effectiveness. In 1989, just two years before the introduction of the world wide web, the University of Phoenix used the online learning service CompuServe to offer a computer-based educational option for students.[18] Today, there is much more research and evidence for the effectiveness of different educational content delivery modes, which prompted the formulation of this review.

Overall, 6 of the 10 studies included in this review supported the use of online learning either individually or in addition to F2F learning for teaching psychomotor skills.[8,9,11-13,16] These 6 studies either found improvement in psychomotor skills with online methods or found no significant differences between online and traditional groups, suggesting that online education could potentially be an effective substitute to traditional education. Two studies demonstrated no additional benefit when online education was provided as a supplement to F2F learning.[15,17] One article did not assess psychomotor skills pretest/posttest but found that all students' skills improved after a blended learning course.[10] Finally, one article appraised in this study did not support online/hybrid education for psychomotor skills. Eroglu[14] found that traditional learning had significantly higher psychomotor performance when compared to online-only education in dental students. Researchers suggested that while students were able to make improvements

in psychomotor skills using online-only methods, F2F remains the gold standard for this type of skill training. This was possibly due to the fact that instructors were forced to convert the F2F class to an online-only format with little notice due to the COVID-19 pandemic.

This review agrees with past literature that supports the use of online education as a supplement to traditional education[19], but expands on previous studies by examining psychomotor skills specifically as opposed to course grades, test scores, or other measures of academic performance.

The results of this review show potential for greater application of hybrid or online learning for the acquisition of psychomotor skills. Online education methods still require some refinement and there are still logistical difficulties that can arise, such as limited access to a personal computer, stable internet access, and a quiet place to work. However, these studies show that these methods of education can allow students to learn psychomotor skills potentially equal to their peers who learn using the traditional methods. This allows for greater accessibility to education that would have previously been difficult or completely inaccessible to some individuals.

On a larger scale these articles also support the idea that if another situation were to occur resulting in students being unable to attend school in the traditional sense that they would still be able to be educated to the level required to produce capable professionals. As these technologies continue to be refined it is possible that remote or hybrid learning could become a viable option for students at all levels to allow equal

opportunities in education and reduce the possible need for school closure should another pandemic occur.

One of the greatest takeaways from the pandemic as well as the studies that were reviewed is that education that was believed to only be possible in person can often be adapted to a hybrid or online setting. It is important that we continue to explore this method of education beyond its use as an alternative method during emergencies as it allows individuals the opportunity to pursue careers that they normally wouldn't be able to due to physical location, disability, access to programs, or maintaining a job while in school.

This review has several limitations to be considered when determining a recommendation. Due to the fact that psychomotor skills have traditionally been taught in a F2F format, there is currently a lack of literature examining the effectiveness of teaching these skills in an online-only format. Many of the articles included in this review utilize hybrid teaching methods but not online-only teaching, making it difficult to determine the potential for online learning as a full substitute to traditional teaching methods. However, due to the onset of COVID-19 restrictions during the 2020-2021 school year, many programs were forced to teach psychomotor skills in a predominantly online format, offering a unique opportunity for researchers. Future reviews will be able to take advantage of the unique research conducted on students during the 2020-2021 school year, where psychomotor skills were predominantly taught in online settings instead of using online learning as a mere supplement to the traditional classroom experience. A second limitation is that some studies in our review exposed different groups to different volumes of instruction, with all groups receiving F2F education and

experimental groups receiving supplementary online education.[15,16] Future research should be done to investigate the efficacy of psychomotor instruction exclusively online, and could also investigate student confidence and satisfaction with psychomotor skills once they enter their clinical rotations.

TABLES

Table 1. Evidence Table

Study (year)	Sample Size	Population	Outcome Measure Description	JBI Score	Findings	Comments
Siebert (2022)	N = 101; 50 in intervention group (blended learning) and 51 in control	RNs and pediatric residents	Number of errors during test of manual defibrillator use	7/9	Fewer median total errors in blended learning (2) than in face-to-face (3); not statistically significant (p=.06) E-learning provides no additional benefit compared with F2F.	Both groups had F2F, blended group had additional e-learning course access.
Webb (2022)	N = 243	Undergraduate occupational therapy students	Well-defined scoring criteria for assisted sit-to-stand, repositioning in chair using slide sheet, inserting slide sheets in bed, fitting sling in sitting and hoisting from a chair	7/9	Students with online supplementation had significantly higher scores compared to F2F refreshers. No detrimental effects to online instruction refreshers compared with F2F refreshers.	All groups had an initial course F2F, then annual tutor-led group had 3 hr refreshers F2F, an online group had access to online program and a 45 min F2F practice session.
Smith (2006)	N = 45; groups of 24 and 21	Physical therapy students from 2 schools	Written and practical examination scores	7/9	No difference in knee practical scores; significant improvement in ankle practical exam scores in multimedia group. Supports use of e-learning.	Group A had F2F demo of knee exam skills followed by 120 mins F2F practice and feedback; had multimedia demo of ankle and 120 min F2F practice. Group B had multimedia demo of knee exam skills followed by 120 mins F2F practice and feedback; had F2F demo of ankle and 120 min practice.

Yaylaci (2021)	N = 60; two groups of 30	Fourth semester paramedic students	Multiple choice test and a recorded simulation of neonatal megacode scenario.	7/9	Blended learning (especially through video) is effective in acquiring both cognitive and psychomotor skills.	All students got F2F lecture, after 10 days, they were graded on skills retained. After another week, students then either received slideshow or video clip with 3 days of access. Evaluated again on scenario.
Hayden (2013)	N = 25	1st year second semester OT assistant students at community college	Quantitative exam measuring cognitive knowledge. Psychomotor skills assessed via video recording of student performing a patient transfer in on campus lab.	7/9	Online learning modules were effective in increasing cognitive and psychomotor scores (pre-test to post-test) in patient transfer skills.	No comparison to F2F only group. All instruction was conducted online via textbooks, streaming video, lab activities, other online documents.
Cantarero-Villanueva et al, 2012	N = 44	Undergraduate PT students in Spain	Objectively structured clinical examination (OSCE) scores from 0-3 in practical exam	8/9	Online learning is an effective supplement to F2F learning for manual skills.	All groups received F2F lecture. Control group given time to access textbooks and class material; e-learning group given same amount of time to use training module.
Cooper et al, 2015	N = 98, 60 females and 38 males; 19 students excluded due to poor attendance	Undergraduate Students studying rehabilitation theory	A 10 cm Likert scale that assessed cognitive, affective, and psychomotor domains.	8/9	No significant differences between the 3 groups (short supplementary video, long supplementary video, or no supplementary materials). Significant benefit for supplemental e-learning when experimental groups were combined.	All groups received F2F. Not sufficiently powered to detect small effects.

Park (2016)	N = 79	Fourth-year nursing students enrolled in a 4-year nursing program	14 item self-efficacy tool, 30 item problem-solving tool, and 16 item psychomotor tool based on CPR and defibrillation	7/9	Over 90% of students showed excellent performance on 9/16 items, with relatively low performance on the remaining items, supporting online supplemental learning as an effective technique.	No control group. All participants were assessed at the end of a four week blended e-learning course on the 16-item psychomotor tool.
Eroglu (2022)	N = 168, 121 F2F, 47 modified online	Students from the 2019-20 F2F dental anatomy course and 2020-21 modified online course same subject	Pretest/posttest 9 hole peg test	9/9	Both F2F and online cohorts significantly improved on 9 hole peg test scores. F2F group improved significantly more than the online group.	Conducted during COVID, course was entirely online and compared to students from previous year cohort who participated in traditional F2F education.
Lindenmaier (2018)	N = 84	Health science students (paramedicine, practical nursing, resp, and MRI students)	Self-competence likert scale, academic competence MC questionnaire, and psychomotor competence	9/9	Addition of online module access did not significantly change psychomotor competence. There was no additional benefit to using online learning as a supplement to F2F.	Both groups received normal classroom training (F2F). The study group received a full semester of access to an interactive online module, while the control group had no access to supplemental information. Authors list low sample size and response rate as possible limitations to achieving statistical significance.

Table 2. Evidence table: JBI Critical Appraisal Checklist for quasi-experimental studies

Study	Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?	Were the participants included in any comparisons similar?	Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	Was there a control group?	Were there multiple measurements of the outcome both pre and post the intervention/ exposure?	Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	Were the outcomes of participants included in any comparisons measured in the same way?	Were outcomes measured in a reliable way?	Was appropriate statistical analysis used?
Siebert (2022)	Y	U	Y	Y	N	Y	Y	Y	Y
Webb (2022)	Y	U	Y	N	Y	Y	Y	Y	Y
Smith (2006)	Y	U	Y	Y	Y	Y	Y	Y	Y
Yaylaci (2021)	Y	U	Y	N	Y	Y	Y	Y	Y
Hayden (2013)	Y	U	Y	N	Y	Y	Y	Y	Y
Cantarero-Villanueva (2012)	Y	Y	Y	Y	N	Y	Y	Y	Y
Cooper (2015)	Y	Y	Y	N	Y	Y	Y	Y	Y
Park (2016)	Y	Y	Y	N	Y	N	Y	Y	Y
Eroglu (2022)	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lindenmaier (2018)	Y	Y	Y	Y	Y	Y	Y	Y	Y

Y = Yes, N = No, U = Unclear, NA = Not Applicable

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