Global Publications Output on Mobile Learning during 2007-16: A Quantitative and Qualitative Assessment

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**Abstract**

The paper examines 12024 global publications on mobile learning research, as covered in Scopus database during 2007-16. The global mobile research witnessed 11.76% annual growth and citation impact of 4.08 citations per paper. The global publication and global citation share of top 10 most productive countries in mobile learning research were 64.76% and 82.16% respectively. The top 10 most productive countries individually contributed global share from 3.12% to 16.45% with largest global publication share coming from USA (16.45%). The national share of top 10 countries accounting for international collaborative publications in mobile learning research varied from 13.24% to 46.68% during 2007-16. Of the total output on mobile learning, Computer Science, among subjects, contributed the largest publication share (73.99%), followed by social sciences (30.32%), engineering (29.33%), mathematics (10.65%), etc. The top 20 most productive organizations and authors together contributed 10.80% and 5.43% global publication share and 24.32% and 17.71% global citation share respectively. Among the total output of 3903 papers in journal, the top 20 journals contributed 24.60% share during 2007-16.

**Keywords:** Mobile, Citation Impact, M-Learning, Scientometric Profile, Quantitative, Qualitative, International Collaboration

**Introduction**

Significant improvements have been witnessed in educational indicators over the years, but challenges remain with regard to the delivery of quality education particularly in developing countries. Much expectations have been placed in new information and communication technologies (ICTs), which can empower teachers and learners by facilitating communication and interaction, offering new modes of delivery, and generally transforming teaching and learning processes. Since the early 1960s, advances in technologies have opened up new possibilities for learning in several ways beyond sitting in a traditional classroom. These new methods include computer-assisted, open, distance, and e-learning, in which formal and informal learning opportunities are supported. During the last decade, the widespread ownership of mobile technologies has encouraged a new surge of evolution in technology-enhanced learning. Recent developments in communications and wireless technologies have resulted in mobile devices (e.g., PDAs, cell phones) becoming widely available, more convenient, and less expensive. More importantly, each successive generation of devices has added new features and applications, such as Wi-Fi, e-mail, productivity software, interactive touch screen, music player, and audio/video recording. In developing nations the One Laptop per Child (OLPC) initiative has been instrumental in distributing educational devices to the underprivileged school-going students. This helps in outreaching m-learning programs to a larger audience.

Mobile phones, among different forms of ICTs, are considered to play significant role in this endeavor for several reasons: (i) most prevalent in society and very fast rise of its penetration rate; (ii) its ownership is increasingly more common in the lower socio-economic segments of society; (iii) a good ‘leapfrogger’ since they use the radio spectrum and therefore, less need for new physical infrastructure such as roads and phone wires, and base-stations can be powered via generators in places where there is no electrical grid; (iv) Besides voice communication, it allows the transfer of data, which can be particularly useful for delivering information...
educational content over long distances. With improvements in processing power, storage capacities, graphics, high-speed wireless connectivity, GPRS, Bluetooth, and 3G, the capabilities of mobile devices have been extended beyond their primary function as simple communication and entertainment tools. Researchers have therefore begun to investigate new uses for various mobile technologies to facilitate learning.

The literatures suggest that mobiles on the one hand impact educational outcomes by improving access to education while maintaining the quality of education delivered. On the other hand, mobiles purportedly impact educational outcomes by facilitating alternative learning processes and instructional methods collectively known as new learning.

**LITERATURE REVIEW**

A number of quantitative studies have been carried in the past on m-learning. Among such studies, Pereira and Rodrigues provided a critical analysis of m-learning projects and related literature, presenting the findings of this aforementioned analysis. It seeks to facilitate the inquiry into the following question: "What is possible in m-learning using recent technologies?" The analysis will be divided into two main parts: applications from the recent online mobile stores and operating system standalone applications. Hwang & Wu reviewed 2008–2012 publications in seven well-recognized Social Science Citation Index (SSCI) journals of technology-enhanced learning to investigate the applications and impacts of mobile technology-enhanced learning. It is found that mobile learning is promising in improving students’ learning achievements, motivations, and interests. 

Hasan & Zhang investigated the longitudinal trends of journal articles and proceedings papers from the SCI/SSCI database in Mobile Learning (ML) using text mining techniques. The taxonomies of ML publications were grouped into twelve clusters (topics) and four domains, based on abstract analysis using text mining. Results include basic bibliometric statistics, trends in the frequency of each topic over time, predominance in each topic by country, and preferences for each topic by journal. Bharadwaj & Jain analyzed 1958 research papers (with 6872 citations) originated from 157 institutes from 79 countries and were published in 64 journals on mobile learning from Scopus and Web of Science database till January 1, 2013. The authors studied the global research trends and various other dimensions in mobile learning using different bibliometric parameters. Hasan & Kumar carried out a critical meta-analysis of mobile learning research based on qualitative descriptions of meta-analyses of m-learning research studies published between 2009 and 2013. The study covered in this paper looks at the conceptual frameworks and theories underpinning mobile learning. In studies, the global experiences of using mobile digital devices for learning, and the factors enhancing or hindering the acceptance and use of mobile digital devices for learning in higher education. Baran et al. presented qualitative synthesis of quantitative and qualitative research aimed to address trends and gaps observed in the literature regarding the integration of mobile learning into teacher education. Saleh & Bhat made a systematic approach to review the literature and provide a more comprehensive analysis and synthesis of articles from the year 2003 to the year 2014. Findings in this study reveal that most of the highly-cited articles are found to focus on the evaluations of mobile learning systems and their design. Experimental methods are found to be the primary research methods for the evaluation of m-learning systems. PDAs, handhelds are currently the most widely used devices for mobile learning but these are expected to be replaced by emerging technologies. Duman, Orhon & Gedik traced how mobile assisted language learning (MALL) has evolved in recent years and analyzed studies published from 2000 to 2012 to examine their characteristics and research trends. A significant number of studies did not base their research on any theoretical framework. Applied and design-based research dominated the field, and these studies generally adopted quantitative research methods. Reflecting on these results, we suggest directions for future research and practices in the field. Wu, Wu, Chen & Huang took a meta-analysis approach to systematically reviewing the literature, thus providing a more comprehensive analysis and synthesis of 164 studies from 2003 to 2010. Major findings include that most studies of mobile learning focus on effectiveness, followed by mobile learning system design, and surveys and experiments were used as the primary research methods. Also, mobile phones and PDAs are currently the most widely used devices for mobile learning but these may be displaced by emerging technologies.

Other mobile related bibliometric research conducted by the authors in the past include overall mobile research, mobile banking, mobile payment research, etc.

**OBJECTIVES**

- To study the growth of world literature and top 10 most productive research output and their citation impact
- To study the international collaboration share of top 10 most productive countries
- To study the global research output by broad subject areas
- To study the trends by identifying significant keywords and the publication productivity and citation impact of 20 most productive organizations and authors
- To study the medium of communication and the characteristics of top 15 high cited papers

**METHODOLOGY**

The study retrieved and downloaded the publication data of the world in mobile learning research from the Scopus database (http://www.scopus.com) for ten years during 2007-16. A keywords, such as “mobile learning” or “m-learning” or “mlearning” was used in “keyword” tag and the “Title Tag” and restricting it to the period 2007-16 in “date range tag” was used for searching the global publication data and this becomes the main search string. When the main search string with restricted to individual top 10 most productive country name in “country tag”, the publication data on the individual country in mobile learning was obtained. The main search string is further restricted to “subject area tag”, “country tag”, “source title tag”, “journal title name” and “affiliation tag”, to get information on distribution of publications subject-wise, collaborating countries-wise, author-wise, organization-wise and journal-wise, etc. For citation data, citations to publications were also collected from date of publication till 30 December 2016. The following Boolean search string appears on the search interface of Scopus,
combining all search operators mentioned above:(KEY("Mobile learning" or "M-learning" or "M-learning") AND PUBYEAR > 2006 AND PUBYEAR < 2017) or (TITLE("Mobile Learning" or "M-learning") AND PUBYEAR > 2006 AND PUBYEAR<2017))

DATA ANALYSIS

- Growth and Citation Impact

The global research output on mobile learning cumulated to 12024 publications in 10 years during the period 2007-16. The annual output in this topic consistently witnessed an upward trend with 11.76% growth up from 599 in 2007 to 1447 publications in 2016. The quinquennial research output in the subject also registered upward trend with 57.36% growth up from 4672 during 2007-11 to 7352 publications during 2012-16. Of the total global research output on mobile learning, 64.17% (7716) appeared as conference papers, 29.88% (3593) as articles, 2.50% (301) as book chapters, 1.16% (140) as reviews, 0.91 (109) as articles in press and the rest as editorials (45), conference reviews (36), notes (26), books (23), letters (17), short surveys (15), erratum (2) and abstract report (1) during 2007-16. The citation impact of global publications on mobile learning averaged to 4.08 citations per publication (CPP) on a 10 years window during 2007-16; but on a five years window it decreased from 6.95 during 2007-11 to 2.26CPP during 2012-16 (Table 1).

- Global Publication Share & Citation Impact of Top 10 Most Productive Countries

The global research output on mobile learning originated from more than 100 countries during 2007-16. Table 2 lists the output of top 10 most productive countries in mobile learning research. The global publication share and global citation share of top 10 most productive countries in mobile learning witnessed marginal decline from 65.45% during 2007-11 to 64.32% during 2012-16. Country-wise, the global publication share of these top 10 countries varied from 3.12% to 16.45%, with the USA accounting for highest publication share (16.45%), followed by China (12.13% share), U.K. (8.09%), Taiwan (6.72%), Japan (4.99%), Germany (4.82%), Spain (4.75%), Australia (3.43%), Canada (3.38%) and India (3.12%) during 2007-16. The quinquennial global publication share of Taiwan increased followed by 1.63% in USA, 1.57% in India, 1.03% in Australia, 0.84% in Spain, 0.38% in Germany, as against decrease by 3.55% in China, 2.62% in Japan, 0.49% in U.K. and 0.31% in Canada from 2007-11 to 2012-16. This demonstrates the dynamic nature of research on global learning across top 10 leading countries.
Organizational Distributors of Publications

The productivity of top 20 most productive organizations in mobile learning research varied from 44 to 92 publications and together they accounted for 10.80% (1298 publications) global publication share and 24.32% (11943) global citation share to its cumulative publications output. Nine organizations have registered publications output above the group average of 64.9. Seven organizations registered citation impact above the group average of 9.20 citations per publication during 2007-16. Nine organizations registered h-index above the group average (11.6). Eleven organizations accounted for national of international collaborative publications above the group average (27.58%). Seven organizations registered the relative citation index above the group average (2.26) during 2007-16.

Most Productive Authors

The productivity of top 20 most productive authors in mobile learning research varied from 21 to 75 publications and together they accounted for 5.43% (653 publications) global publication share and 17.71% (8695) global citation share during 2007-16. Eight authors registered publications output above the group average of 32.65 and eight authors registered citation impact above the group average of 13.22 citations per publication in the table during 2007-16. Eight authors registered h-index above the group average (8.81) and nine authors accounted for national of international collaborative publications above the group average (25.11%) during 2007-16. Eight authors registered the relative citation index above the group average (3.26): P.Seow (6.12), J.Hwang (5.96), L.H.Wong (5.63), C.K.Looi (5.48), H.J.So (4.79), Y.M.Huang (4.27), A. Kukulska-Hulme (3.79) and M.Sharples (3.38) during 2007-16.

Table 4: Most Productive Global Organizations

<table>
<thead>
<tr>
<th>Organization</th>
<th>Papers (TP)</th>
<th>Activity Index</th>
<th>TC</th>
<th>CPP</th>
<th>%TP</th>
<th>%CPP</th>
<th>%ICP</th>
<th>%CPP</th>
<th>RCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Taiwan University of Science &amp; Technology</td>
<td>92</td>
<td>1877</td>
<td>20.40</td>
<td>23</td>
<td>12</td>
<td>11.04</td>
<td>5</td>
<td></td>
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</tr>
<tr>
<td>Open University, U.K.</td>
<td>85</td>
<td>917</td>
<td>10.79</td>
<td>17</td>
<td>21</td>
<td>24.71</td>
<td>2.64</td>
<td></td>
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</tr>
<tr>
<td>Athabasca University, Canada</td>
<td>84</td>
<td>683</td>
<td>8.13</td>
<td>13</td>
<td>52</td>
<td>61.90</td>
<td>1.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>National Institute of Education, Singapore</td>
<td>83</td>
<td>1131</td>
<td>13.63</td>
<td>16</td>
<td>36</td>
<td>43.37</td>
<td>1.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>National University of Tainan, Taiwan</td>
<td>82</td>
<td>1708</td>
<td>20.83</td>
<td>22</td>
<td>5</td>
<td>6.10</td>
<td>5.11</td>
<td></td>
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</tr>
<tr>
<td>National Taiwan Normal University</td>
<td>80</td>
<td>576</td>
<td>7.20</td>
<td>12</td>
<td>8</td>
<td>10</td>
<td>1.76</td>
<td></td>
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<tr>
<td>National Cheng Kung University, Taiwan</td>
<td>78</td>
<td>1003</td>
<td>12.86</td>
<td>17</td>
<td>12</td>
<td>15.38</td>
<td>3.15</td>
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<tr>
<td>National Central University, Taiwan</td>
<td>75</td>
<td>907</td>
<td>12.09</td>
<td>16</td>
<td>14</td>
<td>18.67</td>
<td>2.96</td>
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<td></td>
</tr>
<tr>
<td>Carnegie Mellon University, USA</td>
<td>74</td>
<td>627</td>
<td>8.47</td>
<td>13</td>
<td>23</td>
<td>31.08</td>
<td>2.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical University of Catalonia, Spain</td>
<td>62</td>
<td>316</td>
<td>5.10</td>
<td>10</td>
<td>17</td>
<td>27.42</td>
<td>1.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linnaeus University, Sweden</td>
<td>60</td>
<td>158</td>
<td>2.63</td>
<td>7</td>
<td>17</td>
<td>28.33</td>
<td>0.65</td>
<td></td>
<td></td>
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<tr>
<td>Nanyang Technological University, Singapore</td>
<td>56</td>
<td>313</td>
<td>5.59</td>
<td>10</td>
<td>20</td>
<td>35.71</td>
<td>1.37</td>
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<td></td>
</tr>
<tr>
<td>Beijing University of Posts &amp; Telecommunications, China</td>
<td>56</td>
<td>95</td>
<td>1.70</td>
<td>6</td>
<td>14</td>
<td>25</td>
<td>0.42</td>
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<tr>
<td>Tokushima University, Japan</td>
<td>54</td>
<td>333</td>
<td>6.17</td>
<td>9</td>
<td>6</td>
<td>11.11</td>
<td>1.51</td>
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<tr>
<td>University of Hong Kong</td>
<td>49</td>
<td>222</td>
<td>4.53</td>
<td>7</td>
<td>14</td>
<td>28.57</td>
<td>1.11</td>
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<tr>
<td>University of Nottingham, U.K.</td>
<td>47</td>
<td>442</td>
<td>9.40</td>
<td>9</td>
<td>18</td>
<td>38.30</td>
<td>2.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Georgia Institute of Technology, USA</td>
<td>46</td>
<td>151</td>
<td>3.28</td>
<td>8</td>
<td>13</td>
<td>28.26</td>
<td>0.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tsinghua University, China</td>
<td>46</td>
<td>219</td>
<td>4.76</td>
<td>6</td>
<td>20</td>
<td>43.48</td>
<td>1.17</td>
<td></td>
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</tr>
<tr>
<td>King Saud University, Saudi Arabia</td>
<td>45</td>
<td>125</td>
<td>2.78</td>
<td>5</td>
<td>16</td>
<td>35.56</td>
<td>0.68</td>
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<td></td>
</tr>
<tr>
<td>University of Zagreb, Croatia</td>
<td>44</td>
<td>140</td>
<td>3.18</td>
<td>6</td>
<td>20</td>
<td>45.45</td>
<td>0.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total of 20 organizations</td>
<td>1298</td>
<td>11943</td>
<td>9.20</td>
<td>11.6</td>
<td>358</td>
<td>27.58</td>
<td>2.26</td>
<td></td>
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</tr>
<tr>
<td>Total of World</td>
<td>12024</td>
<td>49105</td>
<td>4.08</td>
<td></td>
<td></td>
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</tbody>
</table>

Significant Keywords

Around 47 significant keywords have been identified from the literature, which highlight possible research trends of research in this field. These keywords are listed in table 6 in the decreasing order of the frequency of their occurrence during 2007-16.
Of the total global research output on global learning, 54.10% (6505) appeared as conference papers, followed by 32.46% (3903) in journals, 10.60% (1274) in book series, 2.65% (319) in books and 0.19% (23) in trade publications. The top 20 most productive journals in research on global mobile learning accounted for 22 to 147 papers each in 10 years. Together these journals accounted for 24.60% of global output (960 papers) reported in journals. The quinquennial global publication share of these top 20 most productive journals decreased from 28.75% to 22.75% from 2007-11 to 2012-16. The most productive journal on global learning (with 147 papers) was International Journal of Mobile Learning & Organization, followed by Computers & Education (107 papers), International Journal of Mobile & Blended Learning (98 papers), Educational Technology & Society (75 papers), etc. during 2007-16 (Table 7).

Highly Cited Papers

There were 50 highly cited papers on mobile learning, which received citations from 102 to 666 during 2007-16. These 50 highly cited papers together received 8618 citations, averaging 172.36 citations per paper. Of the 50 highly cited papers, 40 were in 100-199 citation range, 7 in 200-299 citation range and the remaining 3 in 300-699 citation range. Of the 50 highly cited papers, 24 resulted from participation by single organizations in non-collaborative mode and 26 from participation of two or more organizations (18 national collaborative and 8 international collaborative). Among international collaborative papers, the USA (18 papers) accounted for the largest output, followed by Taiwan (11 papers), U.K. (9 papers), Singapore (4 papers), Canada, Australia, Ireland, Switzerland and Sweden (2 papers each), Israel, Japan, Netherlands, South Korea, Spain and South Africa (1 paper each). The 50 highly cited papers involved the participation of 188 authors and 87 organizations. Of the 50 highly cited papers, 40 were published as articles, five as review papers and conference papers each.

Summary & Conclusion

The global mobile learning research output, as indexed in Scopus database, comprised a total of 12024 publications. Their annual output increased from 599 to 1447 publications in 10 years covering the period from the year 2007 to the year 2016, registering 11.76% growth, and quinquennial 57.36% growth. The citation impact per paper of global publications on mobile learning was 4.08 during 2007-16, which decreased from 6.95 to 2.26 from 2007-11 to 2012-16. Country-wise the global publication share of top 10 most productive countries varied from 3.12% to 16.45% and together they accounted for 64.76% global publications share and 82.16% global citations share. The USA accounted for the largest global publication share of 16.45%, followed by China (12.13% share), U.K. (8.09%), Taiwan (6.72% share), Japan (4.99%), Germany (4.82%), Spain (4.75%), Australia (3.43%), Canada (3.38%) and India (3.12%) during 2007-16. The national share of the top 10 countries accounting for international collaborative publications varied from 13.24% (Taiwan) to 46.68% (Canada) during 2007-16. Computer science, among other subjects, accounted for the largest share of 73.99% in the global output on mobile learning. Medicine registered the highest citation impact per paper of 9.70, followed by psychology (7.28), biochemistry, genetics & molecular biology (5.93) and others during 2007-16. The top 20 most productive organizations and authors together contributed 10.80% and 5.43% global publication share and 24.32% and 17.71% global citations share respectively during 2007-16. Among the total journal output of 3903 papers, the top 20 journals contributed 24.60% share during 2007-16. Of the total research output on mobile learning, the top 50 highly cited publications registered citations from 102 to 666 and they together received 8618 citations, with 172.36 citations per paper. These 50 highly cited papers involved the participation of 188 authors and 87 organizations. These 50 highly cited papers were published in 26 journals, of which 14 appeared in Computers & Education, four papers each in British Journal of Education Technology, two papers each in Journal of Mobile Learning & Organization, followed by...

This paper concludes that the emergence of the MOOCs (massive open online course), open education, open educational resources (OER), blended learning, open and distance learning (ODL), and open and distance education (ODE) will certainly accelerate the m-learning initiatives and m-learning research around the world in the time to come.

REFERENCES


