



A Comparative Study of Mobile Tools and AR Affordances on Collaborative Learning: *From the Perspective of Enhancing College EFL Academic Writing Skills*

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Abstract. This study examined the role and impact of mobile tools and AR as collaborative educational resources with respect to their affordances of facilitating college EFL academic writing. These affordances are proposed for their multimedia learning effects on the development of EFL learners' writing achievement. In order to investigate the role and impact of mobile and AR affordances, the study explored the learners' needs assessment including personas, learning objectives and content, learning strategies and learning context so that the design of learning activities could be formulated under the theory of change. Furthermore, it discusses the differences between the impact of mobile and AR affordances under Haye's writing model, with the living-system approach and DMC as conceptual framework. The findings of this study revealed that the appropriate use of ICT multimedia tools like mobile media and AR play a positive role in improvement of learners' English writing quality. Also, L2 learners' writing engagement and motivation are expected to develop significantly with help from either mobile media or AR. Although ethically speaking this evidence was not conclusive as it was limited by literature analysis without experimental data, it could be predicted that mobile tools are appropriate for EFL collaborative academic writing, given their main affordances of availability, connectivity and accessibility, learners can enjoy circulating assistance at each phase of writing. Meanwhile, AR would be recommended in the same study field for its strong potential and unparalleled affordances of authenticity, motivation and multimediality. Future studies are hoping to explore more comprehensive affordances supported by exact experiments and reliable data.

Keywords: EFL academic writing · collaborative learning · affordance of mobile tools · affordance of AR

1 Introduction

In the context of English as a Foreign Language (EFL), writing ranks top difficult among four basic skills due to its wide diverse interactive activities among learners, writing

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media and writing tasks. Unlike ESL students, EFL students only gain exposure to L2 within classroom settings, while scarcely have access to the English environments outside school. This situation is ubiquitous in China from mandatory education to higher education. In China's universities, college English lessons are still not sufficient to allow students ample opportunities to practice L2 writing. As a consequence, writing is the weakest aspect of English proficiency [1] for Chinese students, especially when they enter college and have to deal with academic writing. Research has pointed out that most college students encounter problems with structure outlining, statements articulating and appropriate words selecting in L2 composing [2]. In addition, they feel frequently suffered from insufficient motivation and commitment during writing process [3]. Consequently, their compositions seldom show a clear structure, and rarely contain thematic statements followed by adequate controlling opinions. As a lack of linguistic resources, college students could perform well neither in consistency and fluency nor in accuracy and logic. Moreover, they often demonstrate a reluctance to finish a writing task following the given subject and the criteria to want.

These issues may be alleviated through integrating cutting-edge technologies into writing practice. The past several decades have noted how technological tools have facilitated L2 writing with a range of informational, communicative, and publishing power, which allows learners to conduct multi-modal practice with feedback, involve in collective learning with oceans of writing materials, and immerse themselves in projects that incorporate multiple learning styles. Among vast amounts of evolving methods, technology-enhanced collaborative writing has brought L2 writing into an exciting new phase. Collaborative writing is derived from Vygotsky's sociocultural theory, which has been proved to be efficient for critical thinking, motivation and autonomy because students can better manage discourse structures, grammar, and glossary usage [4]. Meanwhile, tools that could facilitate collaboration range from wikis, blogs, chats, to web-based word processing are applied ubiquitously. Taking these factors into account, technology-based collaborative writing can not only lead to content development [5] and increased individual autonomy, but also assist in language enrichment and logic building.

According to the latest systematic review of technology-assisted language learning (TELL) affordances concluded by Akbar Bahari [6], CALL (computer-assisted language learning), MALL (media-assisted language learning), RALL(Robot-assisted language learning) and VWLL(virtual-world language learning) could provide various useful affordances contributing to EFL writing. The term 'affordance' is coined by Gibson [7] in ecological psychology, as "what it offers the animal, what it provides or furnishes, either for good or ill". Gaver [8] has made research on technology affordances and believes that affordances should not focus on technologies or users alone, but on the fundamental interactions between the two. Therefore, regarding EFL writing, affordances could be defined as 1) interactions between writers and writing environment; and 2) opportunities for writing activities that are supported by perceived and factual features of technology tools.

Although a long list of affordances from TELL has encouraged writing instructors and learners with unprecedented confidence, challenges never extinguish in the aspects such as a lack of genre-based instruction design, increased cognitive load, developing

reasoning and organizing skills and privileging print over multi-modal writing styles. As for exploring solutions to all these challenges, it is considered that collaborative learning via technological affordances from mobile media and AR are seemingly providing possible learning effects. In brief, mobile technology is chosen for its popularity and convenience for everyday users, while AR is picked because of its novice, immersion and integrity between VR and reality.

Apart from the most obvious affordances such as portability and interactivity, mobile platforms can be applied in EFL writing for their function of resources sharing and access bridging. Nowadays, mobile applications on smart devices have penetrated every aspect of our lives, including education, healthcare, finance and entertainment. Thus, it is worthwhile to explore the educational potential of mobile tools for the sake of their universal usage. Parsons, Thomas and Wishart [9] identify five specific mobile affordances which differentiate e-learning from mobile learning, namely portability, evidence and data gathering, communication, interaction with the interface, and outdoor environment. In particular, it contains features of connectivity and group joining that are fit for collaborative writing. Pushing notice is another feature for administrative benefits. All of these functions can be incorporated into the instructional design of college writing courses so as to improve practice patterns, learning materials and prompt revision and feedback in writing.

On the other hand, with the affordances of visualization and interactivity, AR would bring the real world closer to students thus they can manage expository or descriptive writing with immersive ideas storming with AR provident simultaneously. Academic writing activities involve grasping complex disciplinary concepts, retaining and using difficult lexicon, and acquiring an unfamiliar discourse [10], which make learning isolated from real life to some extent. Fortunately, AR enables learners to have visually enriched experiences that stimulate creative composition [11]. Current studies on AR-based learning are mainly in the fields of natural sciences targeting students from fundamental educational phase. While research on AR in L2 learning is relatively few in cases with vocabulary as the most frequently studied language domain. Therefore, there is a need to add a perspective by exploring the contribution of AR affordances for college students in the context of collaborative EFL academic writing.

To sum, the current study aims to broaden the learning approach of college English writing by scrutinizing specific learning needs assessment first. Then with the effects of mobile and AR affordances, this study will specifically examine how could writing performance related to achievement, proficiency and accuracy be improved with the assistance of these two technological tools.

2 Theoretical Framework

This study is in line with the framework of the living-systems approach to the development of knowledge management systems [12] and digital multi-modal composing (DMC) [13]. Living-systems approach underpinning the development of knowledge management systems starts from the analysis of end-user needs. According to users' needs assessment, an instructional information architecture like a skeleton would be built in the first step, then instructional interaction design and instructional information

design are like blood and muscles to be filled into the system, together with developmental evaluation made through the whole procedure. While in DMC learning program, a range of advanced digital tools and multi-modal resources could be introduced to students, who would generate meaningful writing to represent their understanding of curricular topics. In general, the living-system approach will guide the analysis of learning needs thus leading to the assessment and choice of using technological tools. After that, DMC modal will be applied to meet the needs of EFL academic writing and produce affordances-oriented learning activities thus achieving expected learning outcomes.

2.1 Living-Systems Approach to the Development of Knowledge Management Systems

Most current learning design models are conceptualized to develop learning strategies that remain fairly stable for a long period. In order to construct a knowledge management system that could accommodate constantly changing requirements over time, the living-system approach, which is labeled by autopoiesis theory, has been designed to deal with this difficulty.

The system constructs its own knowledge through the process of accommodating data from the environment, shaping and changing the very structure and nature of the system in the process [14]. The living- system approach is the core to consider media selection since different media affordances would be decided to apply in terms of learner characteristics, learning content and objectives, learning strategies and learning setting and context. Therefore, before the debate on mobile media and AR, a round of needs assessment is required to declare what should be contributed to EFL academic writing.

2.2 Digital Multi-modal Composing (DMC)

Digital multi-modal composting (DMC) stems from multiliteracies approach by the New London Group, which calls for renewed literacy that could define the complex new forms of meaning-making. A social semiotic approach argues that multi-modality is the ‘normal state of human communication’ [13], as people depend on various sorts of socially shaped semiotic resources to make meaning and in different models people can fulfill communication varying from person to person. Multiliteracies may include but are not confined to textual, visual, audio, spatial, gestural, and behavioral modes. Since writing classes nowadays should not be limited within textual reading and handwriting on paper anymore, how DMC could be integrated into writing learning design without risks lessening L2 teachers’ and learners’ attention to linguistic development or better preparing L2 learners for the digital age is worthwhile to explore.

3 Needs Assessment

3.1 Learners’ Personas

When examining personas of potential EFL academic writing learners, the users are mainly undergraduates, who have access to a good education so their social-economic

status is around and above average in China. In university, they have access to the Internet and advanced technology, but the accessibility varies depending on regions and educational resources. With the expectation of their medium-high level in English as a second language, most of them have strong interests in podcasting, infographics, digital storytelling and documentary. Game-based learning environment would be favorable for them while online learning is indispensable due to the global pandemic background and digital advancements.

3.2 Learning Objectives and Content

With reference to Broom's taxonomy, the learning objectives of EFL academic writing are at the application, analysis and creative levels. Though drilling is part of writing practice to polish writing skills better, it should not be the learning objectives set out in the course syllabus. Therefore, single-dimensional training focused on statement, structure or spelling and grammar only are not enough. Digital multimodal composition (DMC) with various tasks integrated with blogs, posters and video projects, considering more demanding affordances like engagement and self-efficacy should be proposed.

3.3 Learning Strategies

When determining which learning strategies are appropriate to accommodate affordances desired in EFL writing, all of technological, educational and social perspectives should be taken into account. Firstly, according to the containing cycle of multi-modal, we could blend visual, audio, spatial, gestural elements into linguistic design. In terms of applying multi-modal into writing, DMC is defined as "a new literacy practice in which students draw on digital technologies texts, images, sound, movement, video and/or hypertext, which address new audience through new genres." [15].

Secondly, the activity theory model could be used as guidance to deconstruct the learning process. In this theory, not only the external aids of technological tools would be selected and compared, but also the interaction among other internal factors will be depicted the influence one another. For example, learners and teachers are no longer the traditional duck-filling correlation in the learning process, all the roles of rules, community, division of labor and writing skills acquisition will count their respective ratios in the process. That is to say, the traditional way of treating language as unimodal could not be recognized anymore. According to Larsen-Freeman and Cameron [16], writing is a complex dynamic system consisting of heterogeneous agents with everything changing continuously. It is non-linear and inextricably interconnected with the context, therefore, the living-system approach and DMC modal would greatly engage in building learning activities.

Thirdly, the norm of writing should be noticed when going into educational affordances. Based on Haye's writing framework [17], six major variables need to be covered while writing, namely: the social environment, the physical environment, working memory, long-term memory, motivation/affect and cognitive processes. Among these major variables, sub-elements such as collaborators, composing medium, visual and spatial memory, beliefs and attitudes as well as task schemas should be analyzed up to date and instilled with the latest methods in the new era.

In conclusion, the needs assessment of EFL academic writing learning, on one hand, should include affordances that could help students to overcome the fear of failure, and a lack of relevance and recognition. It means that affordances are capable of realizing real-time replay, self-paced revision, relating EFL writing to media/life interests meanwhile displaying writing skills. On the other hand, EFL writers would prefer choices over mode, time, topic and tools, and undoubtedly, they like to have civic participation and build up a community of similar learners through acquiring new literacy skills. On the whole, affordances are expected to provide help to foster senses of autonomy, competence, purpose and belonging.

4 Media Selection: Mobile or AR?

4.1 Affordances of Mobile-Based Writing Learning

In Churchill [18]'s reviewing study, he once summarizes mobile affordances into six dimensions, namely "resources, connectivity, collaborative, capture, analytical, and representational". Resources refer to all kinds of digital information available on mobile devices. These resources could be accessed beyond time, place and space as long as there is an internet connection. With this affordance, writing could happen formally and informally whenever inspiration occurs upon writers. The second affordance is connectivity, which makes students never learn alone. Learners have to connect as to finish learning, synchronously and asynchronously. Based on connectivity, collaborative learning becomes possible and effective. Mobile technology allows learners to collaboratively build consensus, form cognition, exchange ideas and manage roles during learning. So all these three affordances can tactically help students with wider creating paths compared to traditional solitude manner of writing.

Strategically, another three technical affordances also provide aid through diversity and extension of mobile media. Nowadays, mobile technology has been equipped with the capacity to capture, store and process multiple forms of data. With these, information becomes easier to digest and transfer while taking notes is no more challenging. After information collection, mobile technology would then act as a tool to aid students develop analytical and scientific learning content. With these tools, students are likely to follow the academic paradigm to implement their writing. Finally, during implementation, students can use mobile tools to create representing words or images that demonstrate their perception when handling writing.

According to what has been discussed above, since the concept 'affordance' was initially proposed in the field of ecology, it may also shed light on the possibility of discussing mobile assisted writing learning ecology from the lens of theory of change. Rudi Keller [19] first proposed usage-based theory of change to elaborate that language composing is a by-product of ordinary language use, which academic writing is underpinning the framework of this theory. Under sociocultural circumstances, formal (in-class) learning and informal (out-of-class) learning are separated and overlapped at the same time. In formal learning, learners' conception would come into being with dual interaction with teachers and peers simultaneously. Teachers' instruction provides learners with resources then learners respond with questions. Meanwhile, learners have negotiations with peers through connectivity and then put forward clarification as follow-up. After learners have

built a relevant concept of their writing tasks, they can continue with writing practice, which neither can be separated from teacher-designed tasks nor be apart from peer's co-participating. Teacher-designed tasks should fully represent teachers' conception in the formal learning cycle; thus, it shows adaption of evaluation on actual learners and factual learning. From this perspective, teachers' feedback will increase opportunities for learners to analyze and reflect before learners could make ultimate modifications. In addition, peer's co-participation as compensation for content generation, is an affordance of capturing external information around. With all these factors working on each other and moving round in a cycle, the odds are great collaboration would facilitate connectivity between learners and peers in many informal environments. In summary, from formal learning to informal learning, the six affordances keep operating their roles that enable learners' conception to regulate practices. Vice versa, the practice would give back reflection upon conception based on all sorts of interaction and feedback occurring in a constant manner (Table 1).

4.2 Affordances of AR-Based Writing Learning

Combining the needs assessment of end-users and Haye's writing framework, what affordances AR could provide in EFL academic writing process at least cover important sub-themes under the six major variables. To be specific, first, the 3D stimulus will help prolong and maintain long-term memory that could have an effect on meta-cognitive scaffolds to benefit writing task schema construction. Then as a very obvious affordance of AR, motivation can not only improve learners' interest in learning, but also enhance their knowledge transferring ability to a large extent. For example, by engaging multi-modal tasks like storytelling, students will have a stronger sense of mission in learning. Meanwhile, instructors and designers need to keep putting appealing visual stimuli on the system interface thus guaranteeing innovation. In the long run, involving parties could form a supplementary relationship and gain mutual support to promote the learning mechanism.

Furthermore, the affordance of affection is essential to learner's beliefs and attitudes. Since students prefer writing in interesting conditions, an instructional designer must create preferable learning surroundings for students. With autonomic beliefs and attitudes toward learning, students will find merits of collaborative writing and have acceptance of tech-aided writing. Additionally, the affordance of self-efficacy in AR-based writing could help students with writing strategies as well as writing approach scaffolding. On one hand, background settings could provide different levels of tasks from easier ones to more difficult ones. On the other hand, students could reflect and evaluate different effects they could achieve under the guidance of different strategies. Last but not least, the affordance of cognitive processing has a direct effect on the distribution of cognitive loads so that students would be released from too much cognitive pressure caused by continuous upgrading of technologies. Generally speaking, when students are immersing in an AR environment, they can have authentic feelings from interacting with VR objects and acquire knowledge from AR-based materials to write more intentionally.

Currently, most competitive cases of AR-based writing are about scientific study, such as species observation journals or satellite exploration reports. Another major type is creative writing. AR is one of the best ways to provide all sorts of contexts for fiction,

Table 1. Mobile affordance for EFL writing under the *theory of change*

Affordance	Effect	Outcome	Learning activities of AR-based writing
Portability	Enable learners to move around and interact with their environment	Writing could be free from the traditional stereotype	Blended writing: learners will carry out writing on both formal and informal occasions
Accessibility (resources)	Access up-to-date and accurate knowledge when and wherever it is needed	Increase the level of new knowledge creation, enhance the awareness of learning in the context	Data-based collaboration: information regarding content, language, and genre would be reached at a click of the mouse
Multimediality (representation)	Utilize the rich toolkit of mobile devices	Learners become resourceful when come to writing	DMC process: various writing forms like BYOD and infographics could be applied; represents adaption of actual learners and factual learning
Connectivity (collaborative)	Share and develop learning and understanding with others	Both teacher-students and peers could link closer and communicate more conveniently	Collaborative learning: learn through interaction and negotiation, thus to accomplish collaboration
Availability (capture, analyze)	Acquire and apply knowledge, skills and feelings in an immediate and relevant setting	Break the limit of time, space and learning forms	Two-way feedback: dual interaction with teachers and peers simultaneously, thus increasing opportunities for learners to analyze and reflect before learners could make ultimate modifications

novels and dramas. Regarding EFL learning, the popular AR app Pokémon Go could offer help in vocabulary learning with focus on prefix and suffix. However, how can AR apply to academic EFL writing among adult students is still needed to explore.

When designing AR-based learning activities for EFL writing, the operating condition and feasible environment need to be taken at primary seats. Besides, elements including interaction-based learning, genre inserting, meta-cognitive scaffolding, and attractive storyline are essential to make the learning as a whole (Table 2).

Table 2. AR affordance for EFL writing under the *theory of change*

Affordance	Effect	Outcome	Learning activities of AR-based writing
Motivation	Relate EFL writing to media/life interests to overcome a lack of relevance	Increase enjoyment and satisfaction in learning while decrease anxiety	Students can learn with DMC with sufficient resources
Authenticity	Showcase writing skills to overcome a lack of autonomy	Fun, meaningful and authentic activities since AR provide real-life information to the real audience while creating the scenes	AR-based tour: provide AR learning materials from topic-related expressions to patterns of genre
Multimediality	Acquire new literacy skills to foster a sense of competence	Mediating effect on the perceived cognitive load and stimulate behavioral intention of students to learn	Meta-cognitive tasks: scaffold writing with various tasks such as KWL chart, mind map and outline
Connectivity	Express ideas and civic participation and build up a community of similar learners to foster a sense of purpose	Increase interaction and collaboration between participants	External resources: use office software, handwriting board, and web.2.0 tools to realize collaborative writing
Locationality	Have choice over mode, time, topic and tool to foster a sense of autonomy	Learners no longer need to travel around to get distant scenario information	Writing tutorial: instant feedback and real-in-time review will be given promptly

4.3 Competitive Analysis Between Mobile and AR Affordances in EFL Writing

Through the two tables, it is clear to read out the following information. 1) Apart from the commonly known affordances, both mobile tools and AR could provide more specific affordances conforming to EFL writing learning activities thus enhancing learners' learning experiences and improving their writing quality; 2) Compared with AR, mobile tools show more explicit affordances of collaboration and connectivity when guiding writing, which may imply at current stage mobile could be more appropriate than AR to support collaborative EFL writing; 3) Compared with mobile tools, AR shows better potential to harness the traditional writing framework with a brand new design concept and operating systems, which demonstrate the feasibility of AR-based EFL writing evolving from singular individuals and VR to more collective learning modes.

5 Conclusion

The study has discussed mobile and AR affordances that could facilitate collaborative learning to develop EFL academic writing in terms of their respective features and

producing possibilities in learning activities. The affordances inform us of the status quo of the media and AR- assisted writing research and their benefits, and the challenges determine the areas that require future direction of such research on EFL writing development.

Under the guidance of the living-system approach for knowledge management system and DMC modal, this study compared the effects of mobile-assisted writing and AR-based context-aware writing on genre-based writing outcomes, typical learning activities, and meta-cognitive scaffolding artifacts. As indicated in the comparison, mobile tools are significant in functions of availability and accessibility in assisting EFL writing. In particular, under the guidance of the theoretical framework, teachers, learners and peers will carry out learning activities along their respective tracks but with repetitive overlaps to circulate during the learning circle. This indicates that mobile-facilitated writing, as an increasingly influential and mainstream means of learning could enjoy more users and being developed more quickly.

At the same time, AR technology is strongly recommended to be integrated into EFL writing applications to make collaborative writing ubiquitous, authentic, and interesting. Since the learning style has moved forward from e-writing to mobile writing to u(ubiquitous) writing, self-regulated writing competence is likely to be fostered through u-learning. Through AR, writing KPIs such as long-term memory, motivation, and self-autonomy in the meta-cognitive scaffolding processes can be effectively enhanced, which is unparalleled by other technological approaches. As an emerging tool of TELL, there is huge potential to tag as AR being put more into digital learning practice.

The implication of this study could be considered from the aspects concerning different personas, learning objectives, and content as well as different learning contexts. Future research can also explore different approaches and learning strategies by comparing other technological tools.

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