

BLENDING LEARNING AT SCALE: SEMI-AUTOMATED STUDY COACHING OVER ASYNCHRONOUS TEXT MESSAGING

AUTHORS

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ABSTRACT

Many educators see tutor support as critical to the success of the online self-learner, but existing research is rooted in traditional job descriptions assigned to teachers and fails to consider the unique challenge of delivering personal human support at scale.

Using data and experience from our development of the LinguaLift language learning platform, we investigate what exactly online learners seek to obtain from a tutor and look for ways for our proportionally small team of educators to meet those individualized needs.

We find that most of the benefits students seek from a human tutor can be provided asynchronously through text messages. Technical solutions such as automated preemptive messaging, intelligent tutor dashboards, and canned responses surfaced by a machine learning algorithm allow the provision of highly personal support at a mass-market price point.

We see an opportunity to counteract teacher shortage by supplementing professional educators and industry experts with less experienced study advisors backed by computer-assisted technology.

KEYWORDS

blended learning, self-directed learning, online education, case study

INTRODUCTION

The purpose of this case study is to understand the unique needs of online self-learners and to investigate possible solutions for the proportionally small team of educators at the LinguaLift online language learning platform to meet those individualized needs at a mass-market price point.

Many educators see tutor support as critical for the success of the self-directed learner (Lentell, 2003; Simpson, 2002). However, tutoring services are not always financially viable. For example, there is ample supply of online tutors for Spanish and English language courses, and course providers can keep their pricing affordable by employing students or tutors located in developing countries. On the other hand, programmers with good teaching skills are so rare that only the most expensive computer science courses can provide the luxury of a human mentor.

That is the problem we encountered while developing LinguaLift. The first course we made available on the site (in 2011) taught the Japanese language, and we soon realized that the combination of high

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salaries in Japan and the young age of the average Japanese language learner made it difficult to provide tutoring at a large scale.

In light of these financial circumstances, we set out to investigate what specific benefits our learners were looking for in a tutor. What patterns emerge in students' requests for human support? Is it necessary for that support to take place in real time, or can it be delivered asynchronously? To what extent can personal support be automated or augmented by technology?

After examining the available data, we developed a hypothesis about the nature of students' needs for human support. We then implemented a partly automated, partly manual online tutoring process based on our understanding of what students needed. Our solution included standardized feedback templates for students' most common questions, which we hoped would free up tutors' time to respond to other student needs. We also developed a pre-emptive messaging system that could help provide the general, subject-independent study support and motivation that is traditionally given by a teacher. With the help of this strategic automation, we hoped students would benefit from the more personal, specialized support and expertise that a tutor with more time could provide.

Existing papers have approached this topic from the point of view of the educator, describing the competencies a tutor should possess, and the activities they should perform (Denis, Watland, Piroette, & Verday, 2004). In our research, we instead took a learner-centred view, and began by considering the benefits autodidacts hope to receive from their interaction with a tutor, if one were available to them.

In this paper, we present students' reactions to, and opinions on, our attempts at automation, and discuss whether they were successful, in that they met students' expectations and motivated students to persevere in their studies. In light of these results, recommendations for improved automation and new, innovative automated solutions are made. We also discuss how an online tutor can adapt to, and benefit from, these technological assistances.

LITERATURE REVIEW

ONLINE STUDENT ISOLATION

Keller and Suzuki (2004) argue that online students confront more motivational challenges because they must work independently and lack the access to the kind of support available to traditional students (Muilenburg & Berge, 2005). Several other studies show that isolation can be a great source of frustration for online learners confronted with technical problems, confusing instructions and delayed feedback (Shieh, Gummer, & Niess, 2008; Motteram & Forrester, 2005). An online tutor who supports learning processes by means of direct interaction is one way to decrease churn (drop-out rate from the course) and alleviate student isolation (Denis et al., 2004).

BLENDED LEARNING

Blended learning is commonly defined as the combination of online and real-life instruction (Macdonald, 2008; Graham, 2006; Garrison & Kanuka, 2004). We believe that ever more education, and indeed life in general, will take place online in the future. Combined with the fact that access to brick-and-mortar education is not a given in many geographies and social classes, for the purposes of this paper, we instead define blended learning as the combination of self-directed and tutor-assisted learning, both of which may be offered via the internet.

TEACHER SHORTAGE

There is an acute shortage of qualified teachers in many countries (Bense, 2016; Berry & Shields, 2017) and a better understanding of how remote human engagement can benefit online students would allow a wider pool of instructors from various backgrounds and experience levels to fill in some of those gaps. Moreover, with the rising popularity of Massive Open Online Courses (MOOCs), a relatively constant number of study assistants face a rapidly growing number of students in need of support. For this reason, there is a growing need for software that assists tutors through automation of repetitive tasks, as well as through data visualization adapted to both tutor and student requirements (Elias, 2011).

ASYNCHRONOUS TUTORING

As new approaches to online education develop, the role of tutors is changing to encompass an evolving set of functions, depending on models of learning and available technology (Ligorio, Talamo & Simons, 2002). Knight's research (2007) disproves the assumption that asynchronous tutoring negatively affects success and retention rates of online students. Moreover, a study conducted by the University of Warwick and the University of Kent at Canterbury (Childs, 2003) showed that there are advantages to asynchronous tutoring. These include longer time intervals available for students to reflect on the information and prepare their answers, mechanisms that allow students to save ideas for further review, and peer-to-peer interaction. However, asynchronous tuition is demonstrably inferior when students face specific problems, because the communication is not as fast and direct as it could be with live tutoring. A course based entirely on asynchronous tutoring may, therefore, have some drawbacks.

METHODOLOGY

PROCEDURE

We first conducted a review of a random sample of past support interactions (N=1,500) and organized one-hour long Skype interviews (N=10) with current customers. Based on this research, working closely with the educators who authored the LinguaLift course, we then conducted an online survey (N=304) of our students.

Neither interviewees nor survey respondents were offered an incentive.

As this is an exploratory case study, it requires a flexibility of data collection and analysis. Although our business practice of continuous, iterative product development prevented us from conducting a long-term controlled study, we were able to broadly assess the effects of our solution using feedback in our customer development surveys (N=167 and N=290).

PARTICIPANTS

10 people (6 female, 4 male) were interviewed as part of the study. Participants volunteered in response to an email sent to paying customers of the LinguaLift Japanese and Russian courses who were actively using the site at the time.

304 people were surveyed at the beginning of the study. Participants volunteered in response to an email sent to all LinguaLift users who had accessed the website at least once in the past 3 months.

To broadly assess the effect of our new solution on customer satisfaction, we analysed responses to the free-form question "What is the primary benefit that you have received from LinguaLift?" in a regular customer development survey submitted by 167 LinguaLift users who had accessed the website at least once in the past 3 months. In a separate survey, we then asked 290 current users to rate how much LinguaLift tutors and study coaches improved their learning.

No detailed demographic data were collected as part of the surveys, but Google Analytics demographic data on our US-based users, combined with insights about our social media followers, suggest that LinguaLift users are predominantly under 30 years old and speak English as their first language.

FINDINGS

Through our investigation, we found that when self-learners look for an online tutor to supplement their learning, they are in fact looking for several specific benefits, not all of which require live interaction with a human teacher.

These benefits can be broadly grouped into two categories: (1) study coaching independent from the material covered in the course, and (2) tutoring requiring a specialist closely familiar with the topic.

STUDY COACHING

Our research has shown that most of the assistance online self-learners seek from a human teacher has to do with the right approach to learning rather than with the course material itself.

1. **Clarity:** Ambiguous instructions are a major source of distress for online students (Essex & Cagiltay, 2001; Hara & Kling, 2000). Furthermore, the abundance of learning content online is both a blessing and a curse, and many students struggle to settle on the right place to start or figure out what to learn next at each decision point. This “paradox of choice” causes mental energy to be wasted on deciding where and how to learn, rather than actually learning (Schwartz, 2004). A recommendation from an experienced educator can mean the difference between actual progress and the illusion of progress wherein a wandering student spends weeks trying different resources only to give up entirely in the end.
2. **Motivation:** Past studies have found lack of motivation to be one of the main factors associated with learner attrition (Aragon & Johnson, 2008; Wolcott & Burnham, 1991; Zvacek, 1991). An experienced educator can work with a learner to identify her goals and interests and advise her on how best to achieve those goals. He can then help devise an achievable study plan that caters to the student’s Zone of Proximal Development (Vygotsky, 1978), follow her throughout her learning journey, and provide emotional support during learning plateaus.
3. **Study skills:** Autodidacticism is an important skill in the fast-changing world of today. Yet, it is rarely taught in our traditional educational system. As a result, learners often use online learning tools without the basic skills required for success (Nunes, McPherson, & Rico, 2000). The combined pressure of having to simultaneously learn the course content, facility with the online learning tool through which it is delivered, and the right study habits can be insurmountable for first-time self-learners. This may explain why students tend to fall into one of two categories: those who have barely completed a single online course, and those who make self-improvement and online education an integral part of their lives.
4. **Accountability:** An important part of effective learning is regularity, and past studies have shown it to have a great effect on student attrition in online courses (Boroujeni, Sharma, Kizdiński, Lucignano, & Dillenbourg, 2016). Experienced autodidacts make a conscious effort to instill study habits which allow them to maintain a consistent study schedule without outside points of reference, but beginner learners can best achieve lasting results through accountability to a third party. The simple feeling of shame when you skip a tweet-length weekly check-up from your teacher after a month-long streak can be the driving force behind steady progress.
5. **Technical support:** Students can also experience distress due to technical difficulties (Essex & Cagiltay, 2001; Hara & Kling, 2000). When technical problems prevent or delay access to

course material, students can feel discouraged and leave the website. If such problems recur in the future, they are likely to drop out of the course entirely and look for other options (whether online or off).

TUTORING

1. **Clarification:** Even the best learning resources contain mistakes (Letić, 2017). With the advent of online learning, the prevalence of misprints improved, at first, compared to traditional textbooks with multi-year intervals between editions. But now that online resources have become more complex, and audio-visual resources that are difficult to proof and update are more common, students must once again guess whether they are faced with a mistake or simply an exception to a rule. A tutor available on hand in such situations can not only reassure the student, but also update the content immediately if a mistake is found, or clarify the lesson with a pre-emptive warning for future readers.
2. **Personalization:** The key to improving both memory and motivation is relatability and relevance to day-to-day life (Merrill, 2008). *Adaptive learning* (fully individualized interaction dictated by an adaptive algorithm) has been a buzzword at educational technology startup events for many years. While the technology shows great potential, we will likely need to wait another decade before it delivers on its full promise. In the meantime, although a human tutor may not be effective at adapting material to the learners' competencies (VanLehn, 2011), they remain best positioned to help a student apply what they learn to their personal circumstances (e.g., adapt an example sentence in a language course to their profile).
3. **Correction:** A common problem of online courses, and particularly language courses, is that they prioritize input over output. Most websites provide a cornucopia of text and audio-visual resources for the learner to consume passively, but most stop at simple multiple-choice exercises as the only means for the student to test their newfound knowledge. Although purely technological solutions are improving (e.g., Duolingo, Grammarly, ELSA Speak), personal correction and feedback from a human remains superior, as indicated by the popularity of online peer-to-peer language correction websites such as Lang-8.

Based on these findings, we conducted a survey of our past and current students (N=304) to prioritize the different needs they hope to satisfy with the help of an online tutor. In the survey, we asked the following questions:

How important or unimportant is the availability of a human tutor who can assist you with an online self-learning course?

As seen in Figure 1, on an 11-point Likert scale, 67% of the respondents rated having access to an online tutor as important, 16% considered it unimportant, and 18% saw it as neither important nor unimportant.

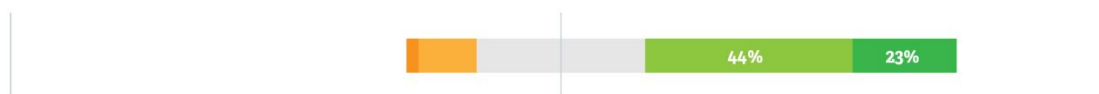


Figure 1. Rating of the importance of a human tutor available to assist with the course.

How fast must you receive a reply to your questions for the human tutor to be useful?

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As seen in Figure 2, most learners responded that they are satisfied if their questions are answered within a day, and just 16% of the respondents expected an immediate reply.

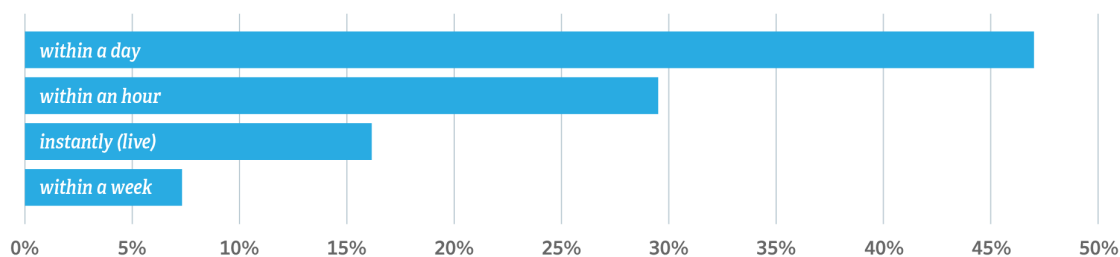


Figure 2. Response speed expectations.

This result confirms our assumption that asynchronous tutoring is an acceptable alternative to live interaction. It is also aligned with previous research findings that online may encourage student participation because it is less intimidating (Citera, 1988; Hobbs, 2002; Warschauer, 1997), and that the extra time available thanks to asynchronous tutoring may allow students to engage with the material more critically and reflectively (Ramsden, 1992; Robinson, & Hullinger, 2008).

List the specific needs you are trying to satisfy with the help of an online tutor.

The free form answers to this question were in line with our findings from support interactions and customer interviews.

One insight gained from this survey was that some learners use tutors to confirm that what they've understood from the lessons is correct, to avoid embarrassment when they first use a particular grammar point or expression in public.

Out of the following benefits a tutor can provide, pick 3 that are most important to you.

As seen in Figure 3, by far the top use for a tutor reported was “offering clarifications” (72%), followed by “exercise correction” (57%), “motivation” (45%), “adapting material to your needs” (44%), “teaching you study skills” (39%) and “devising a study plan” (34%). Students placed little importance on “providing accountability” (18%) and “technical support” (16%).

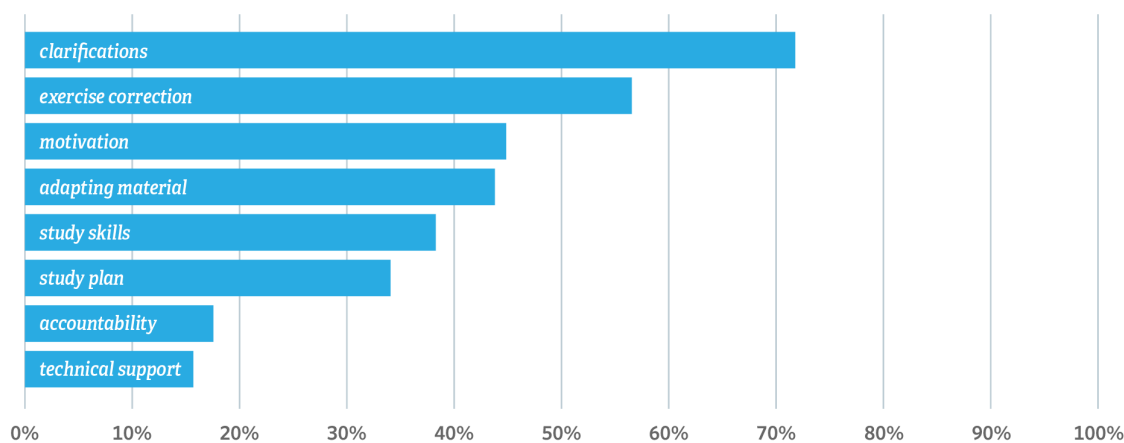


Figure 3. Importance of benefits provided by a tutor.

DISCUSSION

EXAMPLE SOLUTIONS

Delineating the benefits self-learners seek from a human teacher allowed us to consider creative solutions to each of the distinct problems without limitations imposed by the traditional, singular definition of a tutor.

Our primary insight was that most benefits students seek from a human teacher are not time-sensitive (that is, they can be provided asynchronously through text message). Furthermore, we were able to identify and build technical solutions to some of the problems, helping ensure that our tutors spent their time on involvement that brought the most value to the learner.

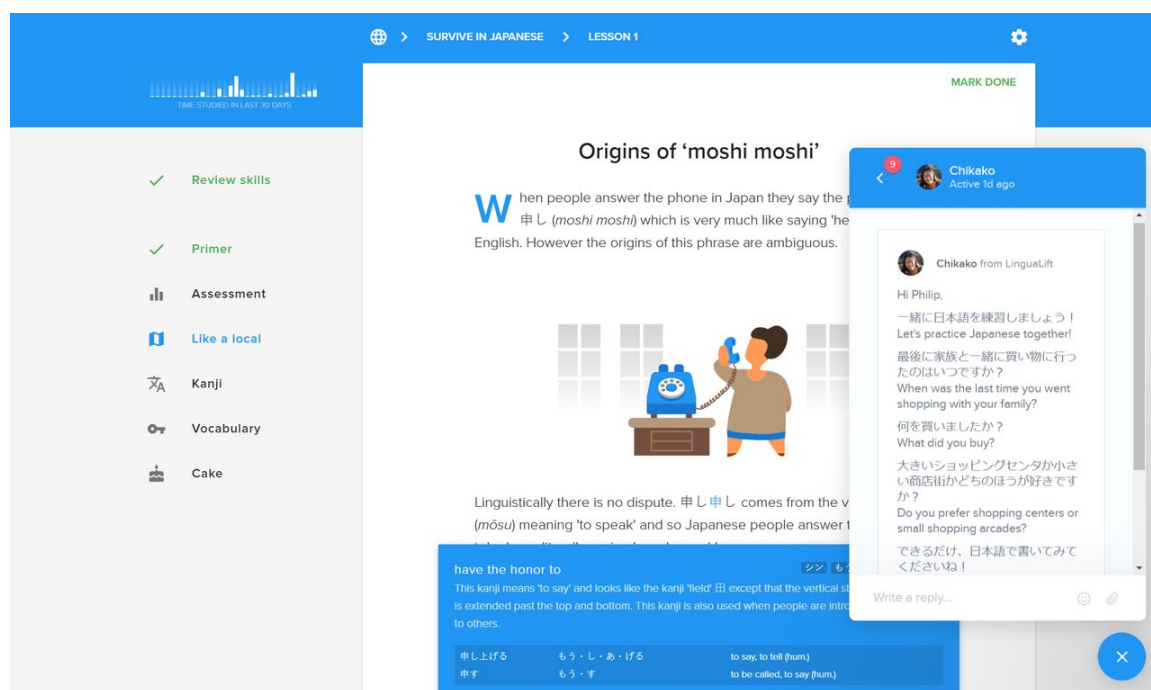


Figure 4. Automated pre-emptive messaging on the LinguaLift website.

Preemptive messaging

Automated messaging during the onboarding process of a new user has been an established practice in startup circles for over a decade, but it has not been actively applied to educational products beyond basic product orientation and customer support. We saw an opportunity to leverage this system as a solution to several of our students' needs.

1. **Product orientation:** The best way to streamline a student's learning journey is to improve the curriculum and the user interface design of the product. Nevertheless, additional support may still be needed, when a learner is less technically savvy or needs to be directed to a third-party resource outside the core learning platform. This was the first step implemented in our automated messaging system, which included unobtrusive explanations of the different features of our website as well as recommendations of dictionaries and mobile apps to use alongside our course.
2. **Study habits:** Although some of our students were experienced autodidacts, others were learning on their own, outside the structure of the traditional educational system, for the first time. To help novice self-learners, we implemented a three-week mini-course on effective study habits delivered over email and within the online platform itself. Using automated

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messages rather than covering the topic within the lessons allowed seasoned self-learners to easily skip to actual coursework.

3. **Triggered prompts:** In response to positive feedback on our product orientation and study habit material, we devised a more elaborate system whereby students would receive asynchronous chat messages in response to triggers within the course (Figure 4). By pre-emptively alerting students to potential challenges, we removed roadblocks before they appeared. We additionally implemented a variety of exercise prompts students were encouraged to perform on their own, and send to the tutors, such as “You’ve now mastered Cyrillic! Spell your name in Russian cursive and send me a photo below.”, or “The Japanese R sound is particularly challenging. Record yourself saying ra-ri-ru-re-ro, and I’ll give you tips on how to improve.”

Many researchers see student isolation as one of the major problems in online education, and a cause of attention problems among self-learners (Haythornthwaite, Kazmer, Robins, & Shoemaker, 2000; Kanuka & Jugdev, 2006; Motteram & Forrester, 2005; Rovai, 2002; Shaw & Polovina, 1999; Shieh, Gummer, & Niess, 2008; Wegerif, 1998). Online resources must, therefore, employ a variety of strategies that would maintain attention throughout the course. The strategies which we employed in our automated messaging include (Keller, 1993; Picar, 2004):

- Stimulating perception
- Giving incongruity and conflict
- Using humour
- Using inquiry
- Requiring participation

By closely matching the messages in style and formality, we made sure students were unable to distinguish between entirely personalised and fully automated emails. This allowed students to build a relationship with their semi-automated tutors and study coaches, which bolstered their personal learning accountability and confidence in our course.

Tutor dashboard

A prerequisite for a scalable blended learning platform is a central repository of study progress information accessible to all tutors and study coaches. There are conflicting views on how best to design learning dashboards, which components should be included, and what exact purpose a dashboard should serve. Based on a review of past research on this topic, we believe that at a minimum, a learning dashboard should aggregate and visualize basic data on each student's progress, their learning profile, and the context of their studies (Schwendimann et.al, 2017). When properly implemented, the dashboard helps the tutors understand and adapt to each students' needs (Nikolayeva et.al.,2018).

Past research confirmed that tutors actively use student progress dashboards when available, but that their design and functionality could be greatly improved (Aleven et.al, 2016). Suggestions included: automating more of the processes teachers do by hand, integrating data from different sources, and pre-emptively suggesting materials for intervention (Xhakaj, 2016). Many of the existing systems also overwhelm teachers with an over-abundance of information, and could benefit from more effective visualization, highlighting data points most relevant to the individual student's learning journey (Abel, 2013; Sutherland, Eagle, and Joubert, 2012). Given the growing popularity of online open learning environments, there is an urgent need to develop dashboards which can analyse aggregate student data and use it to automate all or most of the repetitive tasks where human instructors bring only minimal value (Santos et. al., 2015).

At the same time, research shows that scaling educational systems across a spectrum of learners and teachers is especially difficult, in part because of the significance of contextual variables such as the teacher's experience, the student's academic background, and the course of study (Clarke & Dede,

2009; Dede, Honan, & Peters, 2005). It was therefore important to carefully consider the design of the platform to combine informational clarity with flexibility, allowing for effective simultaneous use by study coaches, tutors, and technical support staff.

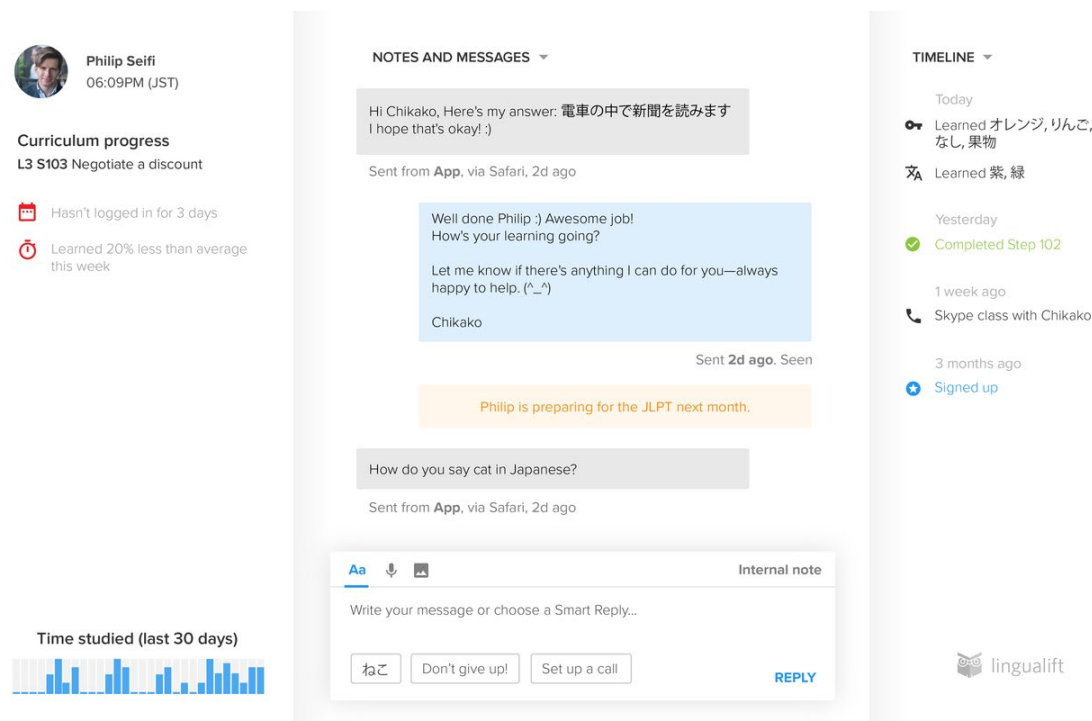


Figure 5. Tutor dashboard combining messaging and student progress data.

Our tutors were given access to user study data along with records of automated messages that had been sent on their behalf (Figure 5). This gave them a quick overview of the student's progress, study goals, and recent struggles, allowing tutors to provide timely support without needing students to introduce themselves during each interaction. Also, we were able to provide tutors with additional details, such as deviations in the students' usual study patterns.

Pre-populated replies

Live or online, a large part of teaching is repetitive. Students tend to ask predictable questions at similar stages of the course. We saw this pattern, which is normally considered the biggest chore of course delivery, as an opportunity to leverage online technology.

We generated a bank of pre-populated answers to frequently received questions, which freed up our tutors' valuable time. Using their professional judgement along with knowledge of the student's unique needs, they would choose an appropriate auto-generated message and customise it appropriately.

Furthermore, we were able to use Machine Learning to predict the most appropriate saved replies based on the content of the student's message, saving additional clicks, and making it even easier to onboard new tutors unfamiliar with the full library of our pre-populated replies (Figure 6).

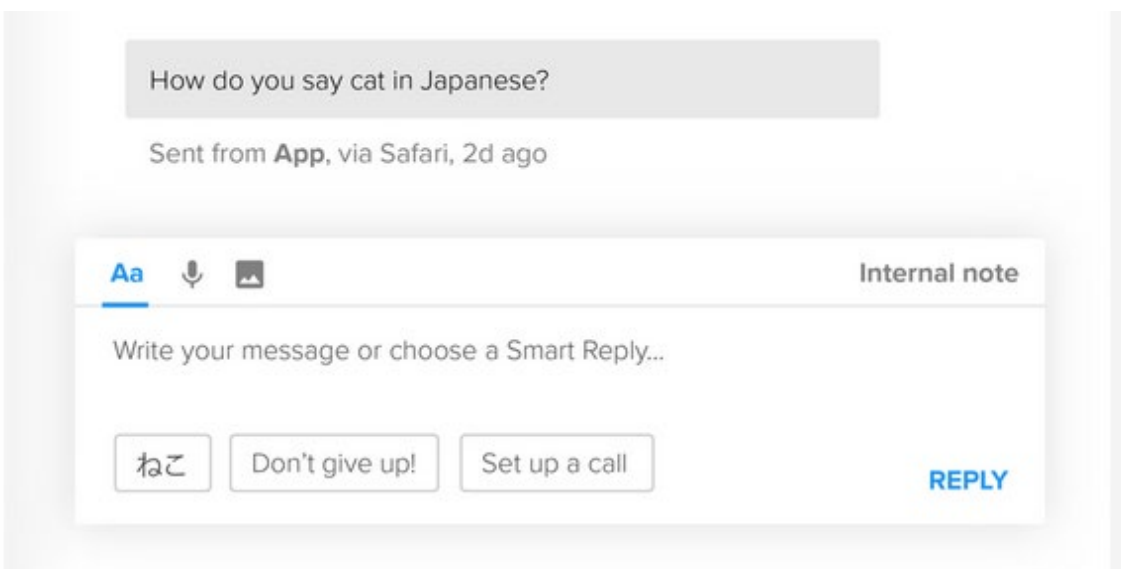


Figure 6. Suggested saved replies in the tutor dashboard.

We conducted an experiment measuring the time it takes one of our experienced tutors to write a reply to the average student question.

The participating tutors all had excellent command of written English, in-depth knowledge of our content and learning platform, and experience answering similar questions many times before. Nevertheless, it took them on average over 3 minutes to answer a student inquiry. Responding to the same questions using saved replies took under 30 seconds. Even more time was saved by beginner tutors who were unfamiliar with these requests, or all the site's functionalities, as well as respondents to recurring technical questions that would otherwise require escalation to higher levels of our support team.

Table 1: Average response times to common student questions.

An audio button is broken!	2min 45s
I'll be too busy next month to study.	3min 00s
I tried to pay, card rejected.	2min 45s
How long does it take to learn Japanese?	2min 45s
How long per day should I study?	3min 10s
How to memorize words?	3min 50s
Will you add a Korean course soon?	2min 00s
I don't get how to use the different particles in Japanese.	7min 00s
Could you help me come up with a study plan?	3min 00s
Why no romaji? I don't want to learn Japanese characters, just speak...	3min 00s

The quality of replies has improved substantially since the introduction of pre-populated replies. This is partially because saved replies are a living document being continually improved and updated by

our team. We have, however, also noticed improvements in answers that did not use a saved reply, as our tutors now had more time and mental energy to write a well-researched response.

In the future, the system could be augmented with an artificial intelligence-based assistant (chat bot) that would be able to respond to basic questions (e.g. simple translations, highly repetitive questions about the site) before connecting the student with a live tutor. This would reduce the response time and improve student outcomes and learning experience through immediate feedback (Yengin, 2010).

STUDENT OUTCOMES

It was unfortunately not viable for our business to conduct a long-term controlled study on the effect of our new tutoring system. Online education is a competitive market, which requires rapid iteration on the product to respond to changing customer needs. The demographics of our student body are also highly seasonal, and can be further biased through advertising campaigns conducted by our marketing partners. The combination of these and other factors makes it difficult to determine the direct reasons for students' satisfaction ratings.

Nevertheless, we were able to broadly assess the positive effect of our blended learning system by analysing user feedback and asking specific questions in our regular student surveys.

In our customer development survey, 8% of respondents (N=167) to the free-form question "What is the primary benefit that you have received from LinguaLift?" mentioned tutors and study coaches directly, often by name. Many answers also mentioned 'motivation' and other benefits that are linked to the tutoring system.

In a separate survey (Figure 7), we asked our current users (N=290) to rate, on an 11-point Likert scale, "How much do LinguaLift tutors and study coaches improve your learning?". 66% of the respondents said our tutors improved their learning, 16% said they did not, and 18% were neutral.



Figure 7. Rating of LinguaLift's asynchronous tutoring.

Last but not least, tutoring is frequently mentioned in unsolicited feedback emails as well as online reviews. Selected highlights:

- *Your online tutoring techniques are..... Unique. The fact that it assigns tutors for each student to monitor his/ her progress is a marvelous way to learn faster. And to think you guys still care about us who lost the motivation to study a different language, makes Lingualift not only as an online tutoring site, but in essence, makes it a virtual loving and caring teacher.*
— R., Philippines
- *What I think really sets Lingualift apart is that there is always a teacher to ask and you don't have to book a whole lesson to ask one question like on iTalki.*
— S., Sweden
- *Instant messaging with the team or the "PERSONAL TUTOR" is simply amazing and the response time with less than 24h is astonishing! There are no robots here, I promise ;)*
— M.
- *Chikako-Sensei has been very helpful with corrections and tips and advice. The motivation from you all has really help me want to continue on with this.*
— S., USA
- *I think that's probably the best part about LinguaLift — having access to real people who want to help and are invested in your learning.*
— K., USA

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- *The way of teaching you is just brilliant. The staff people are so nice and helpful, if you struggle with something, they can surely support you.*
— T., Bulgaria
- *LinguaLift is one of those rare platforms you find on the web [which] comes with a wonderful community of people who supports you throughout your learning experience [...] to put your morale back where it started!*
— J., Indonesia
- *I really like this website! The crew/ staff is very responsive and they try to help as much as they possibly can, which is great.*
— F.
- *LinguaLift is expensive. But it is totally worth it, it's a complete language learning package! It has: brilliant and interactive textbook, powerful flashcards sections, private online teacher(!!!), warm community management and advices on language learning.*
— E., Russia
- *You have a lovely community and very helpful teachers, and I am grateful for each teacher assigned not only to me but others learning on lingualift, for support people are different ages and teaching them a new skill.*
— A., Australia

CONCLUSION

Tutoring is an important aspect of online education frequently requested by autodidacts following Massive Open Online Courses (MOOCs) and other online curricula. Although the role of teachers in the traditional educational system has been the focus of much educational research, less attention has been paid to learners' expectations of them.

Given that most self-learners choose to follow a course out of intrinsic motivation and self-determination, without direct outside incentives, online curricula for autodidacts are inherently learner-centred (Barak, 2015). It is therefore even more important to carefully consider the specific needs students expect a human instructor to satisfy.

Additionally, existing research on tutoring, even when investigated as a complement to computer-aided learning systems, is rooted in traditional job descriptions assigned to teachers. One reason for this approach may be that most authors are themselves part of the academia and have acted as tutors within that system. But online self-learning is fundamentally different from education provision in schools and universities. We believed it to be more fruitful to consider what aspects of the online course can be augmented by human support, rather than how an existing teacher can be incorporated into the system.

Our work with a team of curriculum designers, surveys of students who have used our language learning platform, and interviews of some of our current customers allowed us to create a breakdown of needs that could be satisfied by two types of human support: study coaches and tutors.

After consulting with our user experience design and web development teams, we then found technical solutions that could satisfy some of these needs without human engagement, or at least assist our staff in attending to students more efficiently. These solutions include automated pre-emptive messaging, a sophisticated tutor dashboard that nudges the tutor toward timely intervention, and canned responses suggested to our tutors by a predictive machine learning algorithm.

These solutions allowed us to greatly reduce our service costs, providing a level of personal support hitherto reserved to premium products at a mass-market price point. As a result, we see great potential in the use of innovations presented in this paper to democratize continuing education without negatively affecting the learning process, and to bring personal study coaching to students who would normally be priced out of comparable tutoring services.

We believe that more research should be conducted into the specific needs of online self-learners and how they can be best satisfied by human instructors. Moving forward, comparative studies should be

undertaken to (1) evaluate the relative benefits of synchronous and asynchronous learning in an online environment, and (2) explore the advantages of coaching in the traditional environment as opposed to coaching in the virtual environment. Such further study could reveal new and better paths toward a world where continual, collaborative, and effective self-education takes place on a global scale.

REFERENCES

- Abel T. D., & Evans M. A. (2013-2014). Cross-disciplinary participatory & contextual design research: Creating a teacher dashboard application. *Interaction Design and Architecture Journal*, 19, 63-78.
- Aleven, V., Xhakaj, F., Holstein, K., & McLaren, B. M. (2016). Developing a Teacher Dashboard For Use with Intelligent Tutoring Systems. In *IWTA@ EC-TEL* (pp. 15–23).
- Aragon, S. R., & Johnson, E. S. (2008). Factors influencing completion and noncompletion of community college online courses. *American Journal of Distance Education*, 22(3), 146-158.
- Barak, M., Watted, A., & Haick, H. (2015). Motivation to Learn in Massive Open Online Courses: Examining Aspects of Language and Social Engagement. *Computers & Education*, 94.
- Bense, K. (2016). International teacher mobility and migration: A review and synthesis of the current empirical research and literature. *Educational Research Review*, 17(1), 37–49.
- Berry, B., & Shields, P. M. (2017). Solving the teacher shortage: Revisiting the lessons we've learned. *Phi Delta Kappan*, 98 (8), 8 - 18.
- Boroujeni M.S., Sharma K., Kidziński Ł., Lucignano L., & Dillenbourg P. (2016). How to Quantify Student's Regularity?. In: Verbert K., Sharples M., Klobučar T. (Eds) *Adaptive and Adaptable Learning*. EC-TEL 2016. Lecture Notes in Computer Science, vol 9891. Springer, Cham
- Childs, M. (2003). E-tutoring in synchronous and asynchronous environments. *Interactions, Centre for Academic Practice, University of Warwick*.
- Citera, M. (1988). Distributed teamwork: The impact of communication media on influence and decision quality. *Journal of the American Society for Information Science*, 49(9), 792–800.
- Clarke J., & Dede C. (2009). Design for scalability: A case study of the river city curriculum. *Journal of Science Education and Technology* 18(4), 353-365.
- Dede C., Honan J., & Peters L. (Eds) (2005). *Scaling up success: lessons learned from technology-based educational innovation*. JosseyBass, New York.
- Denis, B., Watland, P., Pirotte, S., & Verday, N. (2004). Roles and competencies of the e-tutor. *Networked Learning Conference 2004*.
- Essex, C., & Cagiltay, K. (2001). Evaluating an online course: Feedback from “distressed” students. *Quarterly Review of Distance Education*, 2(3), 233-239.
- Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *The Internet and Higher Education*, 7(2), 95–105.
- Graham, C. R. (2006). Blended learning systems. *The Handbook of Blended Learning*, pp 3–21.
- Hara, N., & Kling, R. (2000). Students' distress with a Web-based distance education course: An ethnographic study of participants' experiences. *Information, Communication & Society*, 3(4), 557-579.
- Haythornthwaite, C., Kazmer, M. M., Robins, J., & Shoemaker, S. (2000). Community development among distance learners: Temporal and technological dimensions. *Journal of Computer-Mediated Communication*, 6(1).

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- Hobbs D. (2002). Constructivist approach to web course design: a review of the literature. *Int. J. E-Learn.* 1, 60–65
- Kanuka, H., & Jugdev, K. (2006). Distance education MBA students: An investigation into the use of an orientation course to address academic and social integration issues. *Open Learning*, 21(2), 153-166.
- Keller J. M., & Burkman E. (1993). Motivation principles, in: M. Fleming & W. H. Levie (Eds) *Instructional message design: principles from the behavioral and cognitive sciences*. Englewood Cliffs, NJ, Educational Technology Press.
- Keller, J., & Suzuki, K. (2004). Learner motivation and e-learning design: A multinationally validated process. *Journal of Educational Media*, 29(3), 229-239.
- Knight, P. (2007). Promoting retention and successful completion on Masters courses in education: a study comparing e-tuition using asynchronous conferencing software with face-to-face tuition. *Open Learning: The Journal of Open, Distance and e-Learning*, 22(1), 87–96.
<https://doi.org/10.1080/02680510601100184>
- Letić, M. (2017). How should repeated gross mistakes in textbooks be treated?. *Advances in Physiology Education*. 41,99-99. 10.1152/advan.00145.2016.
- Ligorio, M. B., Talamo, A., & Simons, R. J. (2002). Synchronic tutoring of a community on-line. *Mentoring and Tutoring*, 10(2), 137–152. <https://doi.org/10.1080/1361126022000002455>
- MacDonald, J. (2008). *Blended learning and online tutoring: Planning learner support and activity design*. Gower Publishing, Ltd.
- Merrill, D. M. (2008). What makes e³ (effective, efficient, engaging) instruction? *The AECT Research Symposium, Bloomington, IN*.
- Motteram, G., & Forrester, G. (2005). Becoming an online distance learner: What can be learned from students' experiences of induction to distance programmes. *Distance Education*, 26(3), 281-298.
- Muilenburg, L. Y., & Berge, Z. L. (2005). Student barriers to online learning: A factor analytic study. *Distance education*, 26(1), 29-48.
- Nikolayeva, I., Martin, B., Yessad, A., Chenevotot, F., Pilet, J., Prévôt, D., Luengo, V. (2018). How to Help Teachers Adapt to Learners? Teachers' Perspective on a Competency and Error-Type Centered Dashboard. In V. Pammer-Schindler, M. Pérez-Sanagustín, H. Drachsler, R. Elferink, & M. Scheffel (Eds.), *Lifelong Technology-Enhanced Learning* (pp. 596–599). Cham: Springer International Publishing.
- Nunes, J.M., McPherson, M., & Rico, M. (2000). Instructional Design of a Networked Learning Skills Module for Web-based Collaborative Distance Learning, *Proceedings of the European Conference on Web-Based Learning Environments (WBLE 2000)*, 2000, *Faculty of Engineering, University of Porto, Porto, Portugal, 5-6 of June 2000*, 95-103.
- Picar, D. (2004). E-Learning and Motivation. ITEC 860. December 1, 2009.
- R. Sutherland, S. Eagle, and M. Joubert, (2012) "A vision and strategy for Technology Enhanced Learning: Report from the STELLAR Network of Excellence," Retrieved September 27, 2018, from http://www.stellarnet.eu/kmi/deliverables/20120810_d1.8_final.pdf
- Ramsden, P. (1992). *Learning to Teach in Higher Education*. London: Routledge.
- Robinson, C. C., & Hullinger, H. (2008). New benchmarks in higher education: Student engagement in online learning. *J. Educ. Bus.* 84, 101–109 10.3200/JOEB.84.2.101-109
- Rovai, A. P. (2002). Development of an instrument to measure classroom community. *The Internet and Higher Education*, 5(3), 197-211. doi:10.1016/S1096-7516(02)00102-1

- Santos, J. L., Verbert, K., Klerkx, J., Duval, E., Charleer, S., & Ternier, S. (2015). Tracking data in open learning environments. *Journal of Universal Computer Science*, 21(7), 976–996.
- Schwartz, B. (2004). *The paradox of choice: Why less is more*. New York: Ecco.
- Shaw, S., & Polovina, S. (1999). Practical experiences of, and lessons learnt from, Internet technologies in higher education. *Educational Technology & Society*, 2(2).
- Shieh, R. S., Gummer, E., & Niess, M. (2008). Perspectives of the instructor and the students. *TechTrends*, 52(6), 61-68.
- Elias, T., (2011) "Learning analytics: Definitions processes and potential", Retrieved September 27, 2018 from <http://learninganalytics.net/LearningAnalyticsDefinitionsProcessesPotential.pdf>.
- VanLehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. *Educational Psychologist* 46 (4), 197-221.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Warschauer, M. (1997). Computer-mediated collaborative learning: theory and practice. *Modern Language Journal*, 8(4), 470–481.
- Wegerif, R. (1998). The social dimensions of asynchronous learning networks. *Journal of Asynchronous Learning Networks*, 2(1), 34-49.
- Wolcott, L.L., & Burnham, B.R. (1991). Tapping into motivation: What adult learners find Motivating about distance instruction. *Proceedings of the 7th annual conference on Distance Teaching and Learning* (pp. 202-207). Madison, W
- Xhakaj, F., Aleven, V., & McLaren, B. M. (2016). How Teachers Use Data to Help Students Learn: Contextual Inquiry for the Design of a Dashboard. In *Adaptive and Adaptable Learning* (pp. 340–354). Springer, Cham.
- Yengin, İ., Karahoca, D., Karahoca, A., & Yücel, A. (2010). Roles of teachers in e-learning: How to engage students & how to get free e-learning and the future. *Procedia-Social and Behavioral Sciences*, 2(2), 5775–5787.
- Zvacek, S.M. (1991). Effective affective design for distance education. *TechTrends* 36(1), 40-43.