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Evolving the Design of a Mobile Application to Support Transition to Tertiary Education

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Students' transition to tertiary education plays a critical role in their overall post-secondary experience. Even though educational institutions have designed and implemented various transition support programs, most of them still struggle to collect detailed information and provide tailored and timely support to students. With the high adoption rate of smart phones among university students, mobile applications can be used as a platform to provide personalized support throughout the transition, which has the potential to address the shortcomings of existing programs. Moreover, the use of mobile applications to support the transition to tertiary education can benefit from emerging techniques to design applications to support individuals through transition processes. In this paper, we present the design and development process of *myUniMate*, a mobile application that allows students to track and reflect on information from multiple aspects of their university lives. The paper describes the user-centered design approach used in the design, the implementation process, and how the initial version evolved based on our previous study. We conducted a 4-week field trial with first year university students to validate our design.

Keywords: transition, mobile, tertiary education, user-centered design, transition to higher education

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INTRODUCTION

For a significant percentage of the young population, being admitted into universities is one of the many milestones in their lives (Krause et al., 2005). However, this achievement comes with challenges, as starting tertiary education requires students to conduct considerable adjustments in many aspects of their lives. It is for this reason that the first year experience is considered of critical significance to students (McInnis et al., 1995, 2000). In Australia, over one quarter of students in higher education are considering deferring study or discontinuing (Krause et al., 2005), and approximately half of the students who failed to graduate from university withdraw in their first year (Australia Department of Education, Training and Youth Affairs, 2000). During the first semester, withdrawing from university is considered by one-third of first year students (McInnis et al., 1995, 2000), and events that occur in the first year also lead to withdrawals at second and third years (Tinto, 1995). The reason for withdrawal from university are diverse, however, there is a general agreement in the literature that it is the failure of adjustment to the university lifestyle or environmental factors that lead to the majority of withdrawals (Williams and Pepe, 1982; Tinto, 1995). The factors of first year students' withdrawal from university are summarized as (Tinto, 1995):

- a lack of clearly defined goals on the part of the student,
- a mismatch between the student and the course or university culture, and
- a feeling of isolation.

These results suggest that a successful integration of first year students should occur in both academic and social domains, as both are integral aspects of students' university lives (Rickinson and Rutherford, 1995; McKenzie and Schweitzer, 2001; Devlin, 2010). Supporting the transition process from secondary school to the first year at university has long been a challenge for educational institutions. With the increase in the student population and diverse backgrounds (Terenzini et al., 1994), providing supports to first year university students has been increasingly pressing.

Higher education institutions have done extensive research to explore different possibilities to support first year university students during their transition and various transition support programs and technologies have been developed and applied. Generally, we identify three types of transition support mechanisms:

1. Induction programs and transition workshops, which are normally hosted at the beginning of a semester to prepare the freshmen for the university experience.
2. Peer-support, in which "veteran students" and first year teaching staff are encouraged to form groups with first year students and help them in as many aspects of university life as possible.
3. The use of software applications to support the transition to tertiary education.

Traditional transition support programs or orientation and induction programs (Gill et al., 2011) take place at the beginning of a semester, and usually they consist of several different activities that focus on different topics, such as an introduction of academic staffs, information about university facilities and resources, and campus tours. Variations of the traditional programs have also been developed. The UniStart program from the University of Tasmania (Adam et al., 2010) is an example of program that takes place before each semester starts. It is a program that mainly focus on the academic aspect of transition as its aim is to "nurture critical thinking and independent study skills in commencing students." There are an increasing number of universities admitting students to start their studies in the middle of the year and as a result mid-year orientation programs (Sliuzas and Brady, 2015) are also available. These types of programs are usually replications of the ones that traditional take place at the beginning of the year. The limitations of this type of support come with their innate attributes. For as orientations, induction programs, and transition workshops are normally not available throughout the entire academic year, the help they provide will not be accessible by students after the workshops closing dates.

Peer learning and mentoring has been established as a powerful learning tool, with the potential to facilitate students' development in a range of academic areas, and to enhance confidence and ownership of learning (Topping, 1996; Ramsden, 2003; Biggs, 2011). Different types of peer-supports are currently available. The most basic form of support is specially designed transition support strategies developed by university staff. For example, the focus of first year advisors (Burnett and Larmar, 2011) was on developing supporting resources and activities that are available to a specific school. This "one-to-many" support lacks the tailored support available from "one-to-one" support, however, it is a good way to address the requirement of large number of peers. A different type of peer-support is seen in the "Transition in, Transition out" model (Chester et al., 2013), which not only provides supports to entering students but also provides training sessions to graduating students. Graduating students were trained to be mentors as part of a final year capstone course after which they started attending first tutorials to engage first year students in learning, encourage them to take a reflective approach, and enhance skills in both individual and group-based learning. Another example that utilizes peer-support is the "Track and Connect" program (Barnes et al., 2015). This program depends on the "at-risk trends" identified by faculty, such as a lack of assumed prior knowledge to identify the students who may be struggling in the university. At certain times throughout a semester, the identified students are then contacted by selectively recruited senior students to establish a connection between the peers and providing tailored support and advice to the identified students.

Software applications have been used to address the issues of the previous two types of support, making the help available all the time and at a reasonable cost. However, they have not been widely adopted in the support of transition to tertiary education, but instead, many universities are using specifically designed software to facilitate teaching and learning, supporting students' transition in an indirect manner. Previous research (Cheung et al., 2011) have suggested that there is a strong potential to use Facebook to support new students to communicate and interact with each other and (Jenkins et al., 2012) showed that teaching staff can use Facebook to communicate more effectively with students. The idea behind it is that there is a very high adoption rate of Facebook. Once a public Facebook page has been setup, all students can view or "like" the page, and once students "liked" the page, the page updates will appear in the students' personal news feed. Although this approach might be the best accepted approach to update the students with the latest course information, there is a good chance that student miss the update if they "follow" a large number of people and have a huge news stream.

Instead of using existing software applications, some applications have also been developed by researchers to provided transition support. Orientation Online (Smyth and Lodge, 2012) is a web application that aims at making orientation programs longer and thinner by making orientation-related information available once students receive their offer letter and present the information in a modular manner. The benefit of using web applications, both existing applications such as Facebook and specially designed ones, as a medium of transition support is that they are always available to a large audience. However, normally, the information contained in the applications is usually generic, which means there is no personalization built-in, and the nature of web application makes it impossible to deliver real-time notifications. To address these issues, mobile applications have also been developed. A prototype mobile application with various functions (Reminder, Mood & Health, Feedback, and Memo) was implemented and trialed (Zhao and Pardo, 2015). The results of the study suggested that multiple facets of students' lives should be taken into account in the design of transition

support applications, and Lizzio's "5 Senses Model" (Lizzio, 2006) provides a general summary of important aspects that need to be covered. This means, apart from traditional transition support programs, the "5 Senses Model" can also be used as a guide for transition support application designers to decide the aspects that need to be supported.

Lizzio proposed five senses that are central to first year students' success during their transition to tertiary education. The aim of this model was to provide a framework that summarizes ideas and practices that have been shown to enhance three factors of commencing students' satisfaction, engagement, and persistence in higher education. The model is based on student needs from five aspects (capability, connectedness, purpose, resourcefulness, and culture) and can be used to shape transition support strategies. The five senses are as follows: Capability, Connectedness, Purpose, Resourcefulness, and Academic Culture. The Self-Determination Theory (SDT) (Deci and Ryan, 1985, 2000; Deci et al., 1999; Ryan and Deci, 2000) was adopted to quantify "commencing students' satisfaction, engagement, and persistence in higher education" (details will be explained in Section "Questionnaires"). The SDT is a theory of human motivation whose key idea is that "environment allows one to experience feelings of competence, autonomy, and relatedness, the person's motivation toward a given task will be optimal" (Vallerand et al., 2008). SDT theorizes human motivation into three main categories: intrinsic motivation (IM), extrinsic motivation (EM), and amotivation (AM). AM represents the least self-determined type of motivation while IM represents the most self-determined type of motivation (Ryan and Deci, 2000). SDT has been successfully applied to various fields, including work, health management, and education. Previous research (Niemiec and Ryan, 2009) indicated that SDT is central to students overall success. Apart from academic outcomes (Komarraju et al., 2009), intrinsically motivated students tend to do better in school, have lower rates of withdrawal, absenteeism, and dropout, and have lower feelings of anxiety about school (Próspero and Vohra-Gupta, 2007). IM has also been discovered to be associated with psychological well-being independent of academic performance (Burton et al., 2006).

We believe that the use of mobile applications in supporting the transition to tertiary education has real potential and is relatively under-explored. The use of established theories, such as Lizzio's "Five Senses Model" or Deci and Ryan's SDT in the design of mobile applications provides a solid design principle for applied software engineering. However, two factors should be considered when developing software applications to support first year university students. First, end-user involvement in the design process is important to the success of the software (Cho et al., 2014; Dunton et al., 2014); Second, there is only a weak connection between theories and how they should be implemented in terms of software features (Peters et al., 2017). Therefore, a user-centered design (UCD) approach was adopted in this study. The International Organization for Standardization defines UCD as an "approach to systems design and development that aims to make interactive systems more usable by focusing on the use of the system and applying human factors/ergonomics and usability knowledge and techniques" (DIS, 2009). UCD is also considered as an iterative process (Karat and Karat, 2003) which places the attention on the end-users "needs, wants, and limitations" (Nakashima et al., 2009). The process described in this document used UCD to bring end-users closer to the design process and bring the researchers to a better understanding of users' needs of transition support.

In this paper, we study the use of a mobile application in supporting students' transition to tertiary education. SDT (Deci and Ryan, 1985, 2000; Deci et al., 1999; Ryan and Deci, 2000) has been proved to have a variety of positive effects in various contexts. The goal of this paper is to use this theory to investigate users' experiences in educational institutions with a mobile application called "*myUniMate*" which uses self-report and chart visualization to give users a better understanding of themselves and help them cope better with the transition to tertiary education. We employed "User-Centered Design" in the design and development process of *myUniMate*, and implemented an evolved prototype of the application based on previous research (Zhao and Pardo, 2015). A field study was conducted with participants from a first year engineering course in a research-intensive university in Australia. This paper describes the design, implementation process, and results derived from a field study. The objective of the study is to know how the design of the app influence commence students' success, and specifically how the *myUniMate* mobile application:

1. Influenced first year university students' three innate needs (i.e., autonomy, competence, and relatedness) from the SDT;
2. Influenced students' motivation toward learning;
3. Influenced students' learning methodologies.

MATERIALS AND METHODS

The Design of the *myUniMate* App

According to previous studies (Lizzio, 2006), the transition to tertiary education should be supported from different aspects (or "senses") of an individual's life, for example, learning, economy, social, career development, etc. However, supports from the above listed aspects are difficult to provide and to study their effect. A mobile application offers the ideal platform as it is available 24/7, highly personalizable, and can be deployed at scale. Therefore, a mobile application, *myUniMate*, was developed as the major support-delivery medium. A four-phase UCD design protocol was applied in the design and development process of the *myUniMate* app.

- Phase 1: Requirement gathering and analyses.

The main objective of this phase was to gather requirements for the initial design of the *myUniMate* mobile app and understand the needs of first year university students. Methods used in this phase were as follows: literature review, questionnaires, group discussion, and existing knowledge in the project team.

- Phase 2: Design and implementation of low-fidelity prototype.

Requirements gathered in Phase 1 was further analyzed and refined by the project team and a set of requirements were formalized as feature specifications. Low-fidelity prototypes were

implemented based on the feature specifications to enable the evaluation of current designs in a tangible manner.

- Phase 3: Evaluation.

Low-fidelity prototypes were demonstrated to and circulated around first year students, teaching staff, and project team members. Discussions of the current design were held and comments and suggestions on the design were gathered. After Phase 3, the iteration of the design and evaluation process starts, until all project team members considered the current design was deployable.

- Phase 4: Design and implementation of final prototype.

Once the design was considered deployable, a final working prototype was implemented and deployed to the field trial.

First year students, teaching staff, and project team members, such as researchers and developers involved in this project, took part in the UCD design process. There were two main sources for the initial requirements of *myUniMate*: (a) comments and suggestions derived from our previous study; (b) requirements proposed by all three participating parties. After the first phase, the requirements were gradually refined, on which low-fidelity prototypes (wireframes of different components of *myUniMate*) were implemented (Phase 2) and demonstrated to and circulated around all three parties of the project team (Phase 3). Based on the comments and suggestions gathered in Phase 3, low-fidelity prototypes were redesigned and re-evaluated. Several iterations of design and evaluation was conducted, and a working prototype was implemented at last.

The "5 Senses Model" was adopted as a guideline to initiate the design of *myUniMate* to cover possible aspects of students' lives and to evaluate the final design. Especially, *myUniMate* was designed with the aim of directly covering the Capability, Purpose, and Academic senses of the "5 Senses Model," indirectly providing the Connectedness sense and the Resourcefulness sense. The rationale for this design decision is that, in the context of education, a sense of connectedness is best provided to an individual through close interactions with peers, family, and university staff (Lotkowski et al., 2004). On the one hand, students are already using mature commercial chatting platforms as their daily virtual communication media (Woodley and Meredith, 2012) which makes it unnecessary to include such functionality into *myUniMate*. On the other hand, although a discussion board or a chat application can bring students together, integrating such a functionality into *myUniMate* was considered beyond the scope of this project to avoid the inclusion of a new online communication platform for both the developers and the participating students. In terms of resourcefulness, we argue this can be classified as a separate research topic. Almost all information useful for a first year university student is made available through the university website or course-specific websites, but as the students are new to the websites they may have trouble locating the exact information that they are looking for. One of the solution to this issue can be a redesign of the website to display information in a more comprehensible and easy-to-search manner, and thus can be conducted in a separate interface and interaction design research. Furthermore, experience-based information is usually derived from students' personal past experiences or through interaction with other students, which is then within the scope of Connectedness. Therefore, we focus on three of the senses from the "5 Senses Model." *myUniMate* contains six components (ToDos, Calendar, Measures, Notifications, Mood, and Feedback) which form into four major functions: Task Tracking, Visualization, Mood Tracking, and Notification. It follows a detailed description of the functions.

Task Tracking

The Task Tracking function contains two components: ToDo (**Figures 1** and **2**) and Calendar (**Figure 3**), which focus on students' Capability and Purpose in terms of the "Five Senses Model." As university students are expected to work more independently (Macaskill and Taylor, 2010), and this requires the students to have the basic skills to learn, such as time-management and meeting deadlines, and an understanding of how they can best approach their learning. This could justify the inclusion of this task tracking function.

The ToDo component allows a user to entre tasks that she/he needs to do and get it reminded at a certain time. It offers most of the functions that are provided by regular ToDo mobile apps,

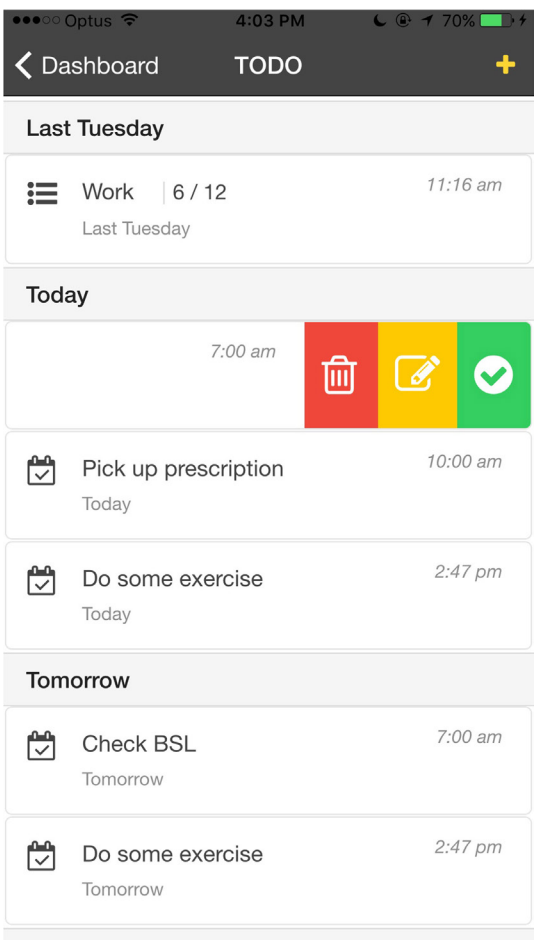

FIGURE 1 | The ToDo Screen.

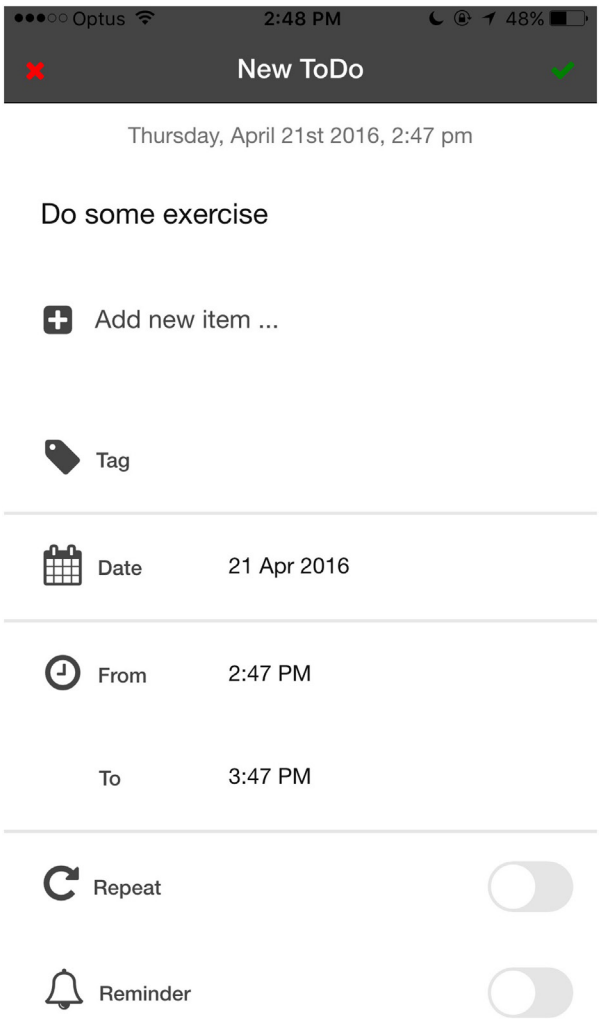

FIGURE 2 | The ToDo Creation Screen.

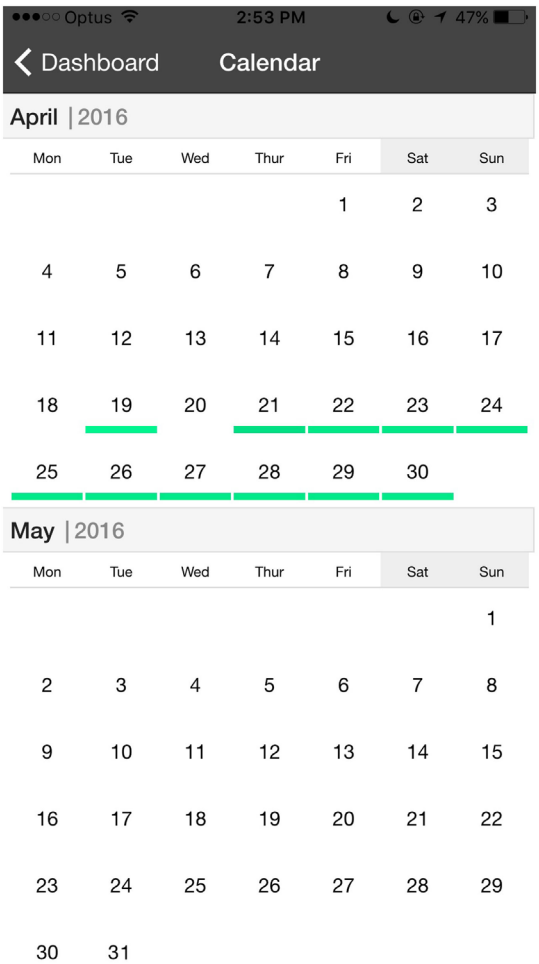

FIGURE 3 | The Calendar Screen.

such as adding sub-items, tagging, and reminder. All ToDo items (tasks) added by a user will be available in the Calendar screen, which provides a different view of all the tasks. The number of tasks in each day is represented by the green bar underneath the date. The darker the color of the bar is, the more one needs to do on that day. By using this function, a participant is able to have an idea of what she/he had completed and what have not (Capability).

Visualization

The Visualization component is composed of the Measures component (**Figure 4**) and the Feedback component (**Figure 5**). This function allows a user to record and visualize different types of information. For each Measure entry, there is a "type" associated with it. For example, if a student would like to know how his/her weight changes, then the type of measure should be "Weight" with a unit of "kg," and an example measure entry could be "69 kg." A user can define her/his own measure types to personalize the type of information she/he wants to track.

The Feedback component visualizes one or more types of measures entered by a user. First, the user needs to select the type or types of measure entries to visualize and specify the time range by selecting the start and end time of the selected entries. In this study, only a line chart and a bar chart were used. Similar to the Task Tracking function, the Visualization function also supports Capability and Purpose through self-reflection.

Mood Tracking

This function (**Figure 6**) enables a user to track her/his mood. The idea of using colors to represent different emotions was inspired by the Mood Meter App (Brackett and Stern, 2014), developed by the Yale Centre for Emotional Intelligence whose goal is to improve emotional intelligence according to the RULER approach (Brackett et al., 2012). In total, the application offers 100 emotion words, and each word has a color and a pair of values representing how pleasant or unpleasant and how high or low energy they feel. A user can also add a short description of her/his feeling together with the reasons that cause the feeling, shown in **Figure 7**.

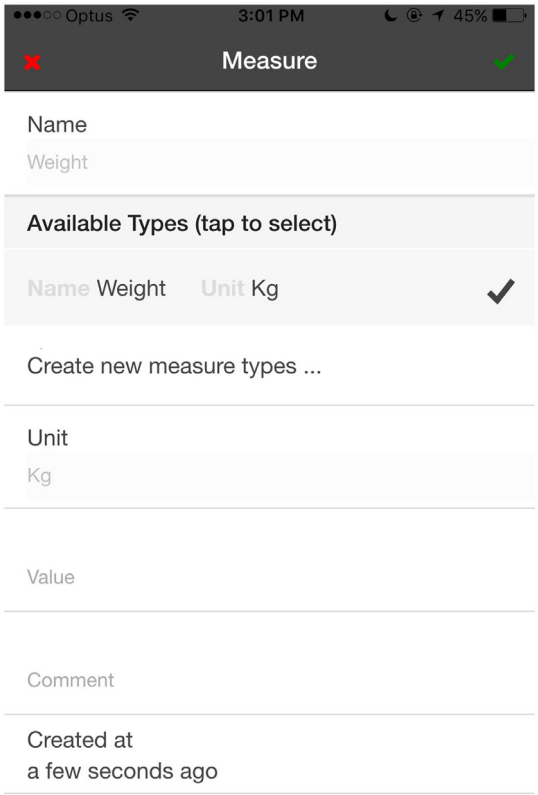

FIGURE 4 | The Measure Screen.

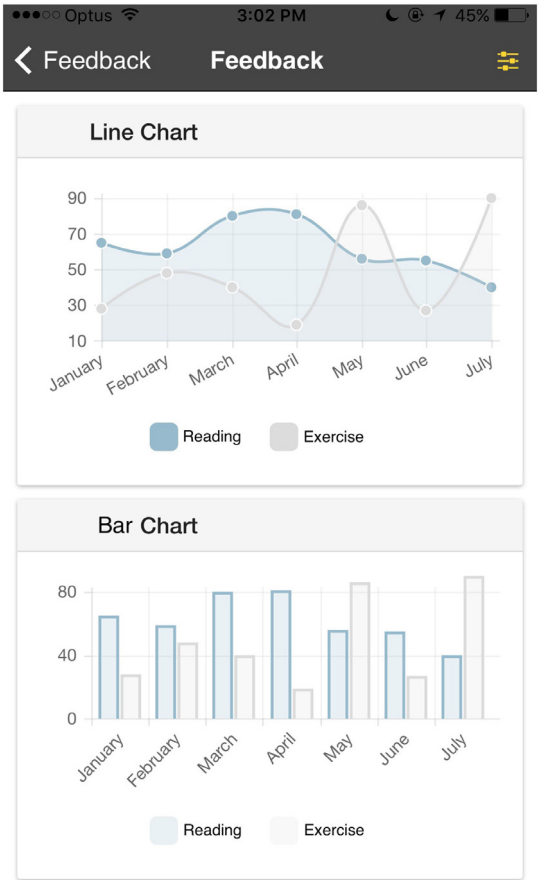

FIGURE 5 | The Feedback Screen.

This functionality does not directly relate to the "5 Senses Model," however, as suggested by the research in the field of "Positive Computing" (Calvo and Peters, 2014), apart from advancing technology and developing tools to make people's lives easier and better, technologists should also strive to use technology to make people psychologically healthier or happier. In *myUniMate*, we use the Mood Track function to allow participants to gage their mood fluctuations and as an attempt to introduce the concept of well-being to them (Kauer et al., 2012; Calvo and Peters, 2014).

Notification

The notification function is implemented as the native notification provided by the iOS and Android systems. When a notification is received, information will be first shown at the notification window, and by clicking on a certain notification, the user is able to view the entire notification within *myUniMate*, shown in **Figure 8**. This function mainly serves the Academic Culture sense, and partially supports the Relatedness sense and Resourcefulness sense.

Both local notification and push notification were used during the field trial. Local notifications are the ones that are generated within the *myUniMate* mobile app based on the ToDo list information entered by the participants. The researchers did not involve in this process and the participants had full control over whether a ToDo task should be sent as a notification, what should be included in a notification and when the notification should be delivered. On the contrary, push notifications were sent by researchers of this study through a server application to all running *myUniMate* instances. All push notifications were about the engineering course from which the participants were recruited. There was no personalization in the notifications, which means all participants received the same set of push notifications. Push notifications were sent every other day, at random times. Example push notification texts are:

N1: Please, make sure to complete assignment 1 on time. It's due on this Sunday.
N2: If you have any question, feel free to ask your classmates, tutors, or lecturer. They will be happy to help you out.
N3: Normally, you can learn new things through exchanging ideals with friends.
N4: You can always find useful information about XXXX (course name) on the course website. Or, you can ask the tutors or the lecturer.
N5: Tracking your tasks can sometimes make things easier.

N1 is an example of reminders of the important dates for a course, which tells the students that the deadline of an assignment is approaching and suggests them to complete the assignment on time. N2, N3, and N4 are sample suggestions for the students to

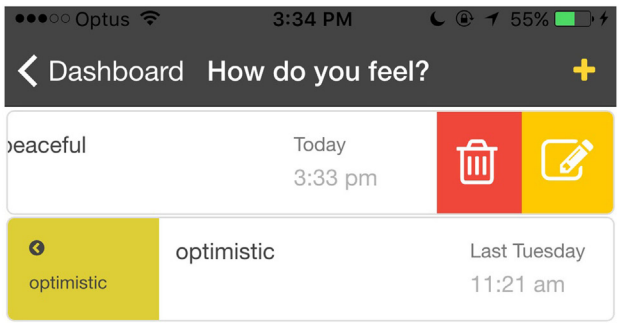

FIGURE 6 | The Mood Screen.

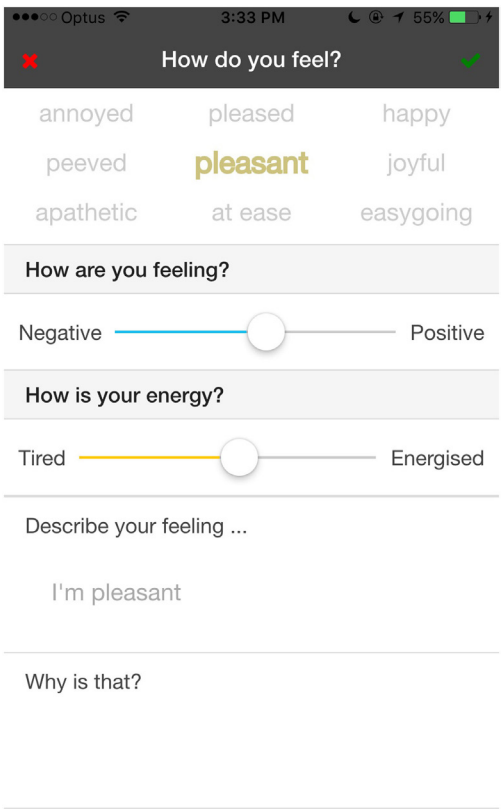

FIGURE 7 | The Mood Creation Screen.

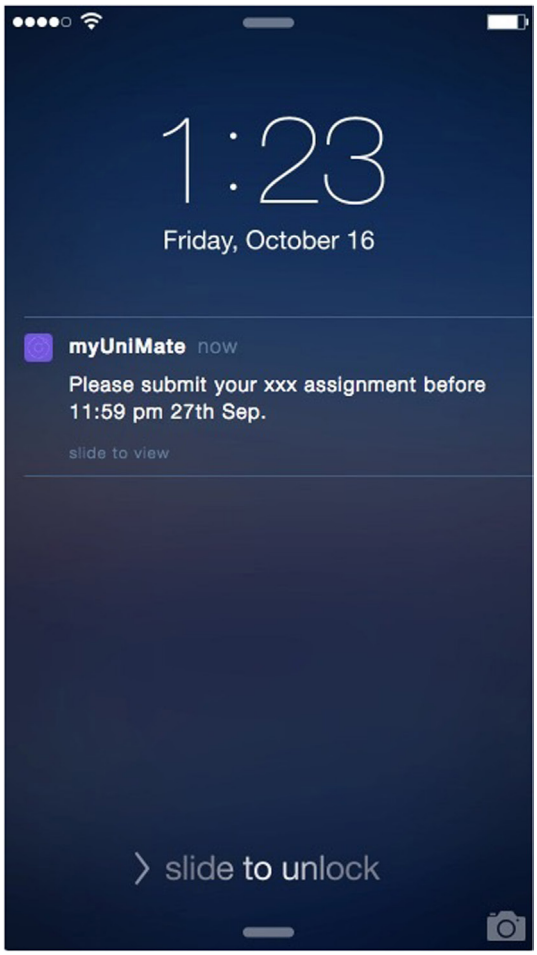

FIGURE 8 | Push Notifications.

TABLE 1 | Field trial design.

	Timeline	Field trial
Questionnaire session 1	Week 1	Background Information Questionnaire (BIQ), Academic Motivation Scale (AMS), BPNS, Learning Climate Questionnaire (LCQ), and RSPQ
App usage	Weeks 2–5	Use myUniMate for 4 weeks
Questionnaire session 2	Week 6	BIQ, AMS, BPNS, LCQ, and RSPQ

have more interactions with the others and information about where to find course-related information. N5 is a recommendation to use the Task Tracking function more.

Procedure

Table 1 demonstrates the design of the field trial. Study participation included two questionnaire sessions and at least 28 days (4 weeks) of using the *myUniMate* mobile application. The questionnaire sessions were conducted in the week before and the week after the 4-week app-usage period. During the first questionnaire session, all participants were asked to complete a set of questionnaires and during the second questionnaire session, participants were asked to complete the same set of questionnaires. After the first questionnaire session, participants were instructed to install *myUniMate* on their personal mobile phone and enter her/his own tasks into the app, which means a participant was expected to know what she/he needed to do (Purpose). During the following 4 weeks, participants were asked to use the mobile application in the ways that they prefer. The second questionnaire session took place after the app-usage weeks.

Recruitment and Participants

This study was approved by the University of Sydney Human Ethics Research Committee (protocol 2015/473). The recruitment was conducted in the first lecture of a first year engineering course in an Australian university in the year 2016. The course lecturer introduced the project to the students and provided contact details to allow students to opt in the study. 11 participants (3 females/8 males) took part in the trial. All participants gave written informed consent before the study. At the time of the study, all participants were aged between 19 and 21 and were doing their first or second semester study during their first year of university. All participants were regular mobile phone users with a mobile phone running Android or iOS system. A gift card worth of 20 AUD was given to each participant to compensate her/his time.

Questionnaires

The Five Sense Model given by Lizzio was used as a guideline to evaluate the design of *myUniMate*. The target of the model was to enhance first year university students' satisfaction, engagement, and persistence. In order to quantitatively measure students' satisfaction, engagement, and persistence in learning, five questionnaires were used in this study: Background Information Questionnaire (BIQ), Academic Motivation Scale (AMS) (Vallerand et al., 1992), Basic Needs Satisfaction in General (BNSG) (Deci and Ryan, 2000; Gagné, 2003), Learning Climate Questionnaire (LCQ) (Bartram et al., 1993), and Revised Study Process Questionnaire (R-SPQ-2F) (Biggs et al., 2001). The first questionnaire was created by the researchers involved in this study, while the other four questionnaires were standard questionnaires that had been evaluated formally. BPNS, LCQ, and R-SPQ-2F are all instruments revolving around the SDT.

The five questionnaires were used in the field trial to evaluate the effectiveness of *myUniMate*. When applying the AMS, BNSG, and R-SPQ-2F questionnaires, students were instructed to use the engineering course that they were recruited from as context with an emphasis on the use of *myUniMate*. The reason for this request is that originally, these three questionnaires were designed to gage students' learning motivation, basic needs satisfaction, and learning approaches employed in a certain context. The context is normally a course taught by a lecturer and the teaching methods the lecturer uses. However, in our case, we would like to know students' thoughts on the mobile app rather than the overall learning environment. Therefore, to have a more accurate measure of the influences of *myUniMate* on the students we asked the participants to take the mobile app into consideration when answering questions during the questionnaire sessions. On the other hand, LCQ was used to measure students' self-perceived autonomy support from the overall learning environment as a reference.

Background Information Questionnaire

This questionnaire was created by researchers of this study and mainly containing questions regarding a participant's demographic information, self-perceived university life, and experience with mobile applications that are used to support transition to tertiary education.

Academic Motivation Scale

The AMS is a scale to measure motivation toward learning. AMS was originally developed in French and translated in English. This scale was selected to gage the changes of participants' learning motivation. Although learning motivation is not one of the three factors supported by the Five Senses Model, it is closely related to students' engagement and persistence in learning, and as shown in previous studies in SDT (Próspero and Vohra-Gupta, 2007), the more intrinsically motivated students tend to have better performance in examinations.

This scale is composed of 28 items subdivided into seven subscales assessing three types of IM (IM to know, to accomplish things, and to experience stimulation), three types of EMs (i.e., external, introjected, and identified regulation), and AM. IM to know is seen when an individual engages in a behavior for the satisfaction experienced while learning or trying to understand something new. IM toward accomplishments occurs when an individual engages in a behavior for the pleasure experienced while trying to accomplish a task or create some thing. IM to experience stimulation transpires when an individual engages in a behavior to experience stimulating or exciting sensations.

Extrinsic motivation lies in the center of the continuum of self-determination. EM represents actions taken to achieve a goal or reward beyond the activity itself. There are three subscales included in EM. These are listed in order from the most to least self-determined forms of regulation: EM identified, EM introjected, and EM external. EM identified is when an individual truly values a behavior, even though they are not doing it because they like it. EM introjected is when one engages in a behavior to maintain personal expectations or avoid guilt. EM external is when an individual participates in an activity solely as a means to obtain an external reward or avoid punishment. AM lies at the opposite end of the self-determination continuum from IM. AM refers to the absence of intention or motivation. In this study, AMS was used as a measure of learning motivation of participants.

Basic Needs Satisfaction in General

Basic Needs Satisfaction in General was designed to assess the extent to which people satisfy with their lives. Students' satisfaction of the learning environment was of the three factors supported by the Five Senses Model. In this study, this instrument was used to gage first year students' satisfaction in the first year university environment especially the satisfaction with *myUniMate*. This scale has 21 items concerning the three needs for competence, autonomy, and relatedness which is central to the SDT. Relatedness refers to the desire to feel connected to others. Competence refers to a propensity to have an effect on the environment as well as the capacity to obtain valued outcomes, and autonomy refers to the individual's desire to self-organize experience and behavior and to have activity that would be concordant with one's integrated sense of self. This instrument was used to assess participants' basic need (autonomy, competence, and relatedness) satisfaction as a result of app usage. We emphasized that the participants should consider the use of *myUniMate* mobile app as the context to answer this questionnaire.

Learning Climate Questionnaire

Learning Climate Questionnaire was adapted by Williams and Deci (1996) from the Health-Care Climate Questionnaire. This scale contains 15 items about the degree to which students' instructor supports their autonomy and the score of it is simply the average of individual item scores. Higher average scores represent a higher level of perceived autonomy support. As stated in SDT (Vallerand et al., 2008), people tend to develop IM in an autonomy supportive environment and LCQ was used to measure participants' overall self-perceived autonomy support in the field trial. The actual course that each participant was recruited from should be used as the context to answer this questionnaire. We used the LCQ questionnaire result as a reference for the analysis of BNSG result to highlight *myUniMate*'s influence on participants' autonomy.

Revised Study Process Questionnaire

RSPQ was developed with the aim of evaluating the learning approaches of students and in this field trial we used this scale to evaluate what learning strategies were used by the participants. This instrument groups the questions into four scales: deep motive (DM), deep strategy (DS), surface motive (SM), and surface strategy (SS). DM represents the internal motivation of the learner, for example, the satisfaction from learning new knowledge. DS stands for the use of different methods to gain knowledge, e.g., someone perform self-test after a lecture should be considered of DS as it can enhance learning result. SM is contrary to DM, and it stands for the most straightforward target of learning, such as passing an exam. Similarly, SS opposite to DS, and it refers to the types of learning activities that only finishing the homework, preference of memorizing over understanding, etc. The score of each of these variables is computed as the sum of the questions included in the corresponding category (Biggs et al., 2001). In this study, we used this questionnaire in a two factor, deep and surface approaches as indicators of the learning approaches used by the participants. For each of the four scales, there are five questions, and the questions should be answered in a 5-point Likert scale. Therefore, the maximum score for all four scales is 20 points. Students' engagement in learning was measured by the RSPQ questionnaire. Apart from being one of the factors supported by the Five Senses Model, learning engagement is also an important indicator of student success in general. As suggested in de Raadt et al. (2005) and Pardo et al. (2015), students engaged with the learning environment tend to have better performance in examinations.

Data and Analysis

The data used in the analysis are from two data sources: (a) app interaction data (tracked within *myUniMate*); (b) questionnaire answers from the five questionnaires (details can be find in Section "Questionnaires"). Both quantitative and qualitative mechanisms were used to analyze the data.

For the app interaction data, we used quantitative method to calculate the means and SDs of different types of interactions performed by the participants. The tracked interactions include: screen view counts, screen navigations, button clicks, and data entry. We also separate data entry actions from pure "click-throughs" as sometimes clicking through different screens can be a random action. The result of this analysis is an overview of participants' preferences over different functions provided by the app.

The BIQ required text-based answers, and we used affinity analysis to analyze answers that are related to students' university experiences, learning experience, and comments on the *myUniMate* mobile app. Different themes were extracted from answers to the same question given by different participants, which means for each question, we discovered at least one theme of all the answers. This process was conducted by three researchers to enhance reliability and disagreements were resolved through discussion. The other four questionnaires require value-based answers and, thus, only quantitative methods were used. We conducted paired-sample *t*-test using SPSS (SPSS Inc. Released 2013. IBM SPSS Statistics for Macintosh, Version 22.0. Armonk, NY, USA: IBM Corp.) to gage the changes between pre- and post-questionnaire answers and the Cohen's *d* value was calculated to analyze the effect size.

RESULTS

In general, participants' text-based answers to the pre- and post-questionnaires reflect the same, and some of the comments can help us interpret the quantitative analysis results. At the beginning of the study, most of the participants are confident to do well, "…I am confident, because I am just so good…" commented by P-10, and dedicated, "… I can be dedicated to it…" commented by P-9. Participants tend to be positive in their overall university life, especially academic outcomes. P-1 mentioned that "…since it's still [the] first year, I assume the courses are designed for most people to adapt [designed to fit the ability of most students]." P-10 also mentioned that "[in order to excel in a course, I need] to be [take] more initiative [in learning]."

Although the participants held positive view toward their university lives, most of them were under pressure from the academic aspect. "The competitiveness was being quite underestimated after the first semester, and there is more pressure coming toward me since the start of this semester.," a comment given by P-2, suggested that she/he underestimated the academic pressure. P-10, as an international student, felt the pressure of communication, as she/he commented that "… I get used to the life here, but as an international student, sometimes communication with local people would be a little difficult for me."

Engagement

To assess participants' engagement with *myUniMate*, we analyzed the usage logs and post-study questionnaire answers. Three measures are used as indicators of participants' engagement: the number of time a screen is accessed by a participant, the number of time data is entered on a screen, and app-usage duration.

Not surprisingly, the engagement peaked at the beginning of the 4-week app-usage period and plateaued afterward, which can be explained by the novelty of *myUniMate*. As shown in **Table 2**, on average, *myUniMate* was accessed 6.55 times per day per participant, and 3.09 entries were made daily. This result is much

better than the study result of *myUniMate* (v1), which suggests that the new version has a significant improvement over the previous version.

The "App Usage Duration" is only used as a proxy for measuring the length of user interaction with *myUniMate*, as actual interaction time is very hard to be measured.

In **Table 3**, we break down the measures shown in **Table 2** into different screens. Components with higher number of access rate have been highlighted in bold and italic font. The ToDo component was the most used during the trial, which suggests that this component was perceived more useful by the participants. This is consistent with answers in the post-study questionnaire. In the post-study questionnaire, we asked what feature of *myUniMate* participants liked best. Nine participants (out of 11) mentioned that the ToDo component was (one of) the most useful. P-3 mentioned, "…, it was really helpful as it usually reminded me of tasks that I hadn't done." No negative comments were given to the ToDo component.

Apart from the ToDo component, the Measure component and the Mood component were also used more than the others. However, mixed feelings on these two components were expressed in the post-study questionnaire answers. For the Measure component, P-11 mentioned that "At first I didn't know what the Measure function was for, but gradually I discovered that it allows me to enter any type of information that I want to record. The design is fine, [but] it is just that I'm not familiar with tools that allows me do this." Similarly, for the component Mood, P-1 mentioned, "…, that's cool to trace back and see how I've been so far." However, P-6 wrote "…, I don't know what 'mood' is really for."

Self-Perceived Support from *myUniMate*

Basic Needs Satisfaction in General and LCQ measure students' self-perceived needs satisfaction and autonomy support, respectively. These two aspects, needs satisfaction and autonomy support, are considered related in SDT (Deci and Ryan, 1985, 2000; Deci et al., 1999; Ryan and Deci, 2000). Specifically, normally when the innate needs of an individual are satisfied, she/he tend to feel more autonomy supported. We, therefore, use both questionnaires together to see how *myUniMate* was perceived by participants in terms of need satisfaction and autonomy support.

TABLE 2 | Summary of daily engagement measures (overall).

Engagement	Mean	SD
Access (times)	6.55	2.62
Entry (times)	3.09	1.30
Duration (min)	7.45	3.01

TABLE 3 | Summary of daily engagement measures (by screens).

Screen	Access	Entry	Duration
ToDo	***2.15***	***1.62***	***2.61***
Calendar	0.24	NA	0.44
Measure	***2.23***	0.63	***1.83***
Notification	0.05	NA	0.02
Mood	1.33	0.84	***1.95***
Feedback	0.55	NA	0.60

Basic Needs Satisfaction

The BNSG questionnaire was used to assess the level of the three basic psychological needs, autonomy, competence, and relatedness, which were satisfied from the students' point of view. **Table 4** provides a summary of the paired-sample *t*-test between the pre- and post- test.

Participants' perceived support of competence increased from 4.58 to 5.24 [$t(10) = -3.01$, $p = 0.01$]. The support of competence is provided by the "Task Tracking" and "Visualization" components. As all tasks were entered by the participants themselves, the completion of tasks could give participants a sense of fulfillment, which is then translated into competence. The visualization component could also give participants a visual view of their progress. Therefore, we reject the null hypothesis that there is no difference in participants' self-perceived competence. Furthermore, the Cohen's effect size value ($d = 0.91$) suggested a moderate to high practical significance.

The perceived support of relatedness increased from 5.13 to 5.65 on average [$t(10) = -2.62$, $p = 0.03$], with a Cohen's effect size value $d = 0.79$. This suggests that although *myUniMate* did not provide support for relatedness directly, participants were still able to get such support from the interactions with the app.

On the contrary, the perceived support of autonomy decreased from 4.79 to 4.42 on average [$t(10) = 2.39$, $p = 0.04$]. This result can be interpreted as with the *myUniMate* app, the participants felt compelled to perform tasks listed in the app. One example factor could be the notifications delivered to the participants. All notifications delivered to participants were reminders based on their entries in the Task Tracking component. If notifications were delivered at an inappropriate time, even though the delivery time was set by participants themselves, they could still feel pressured to complete the tasks.

Overall Autonomy Support

Participants' overall self-perceived autonomy support was measured using the LCQ. These data portrait the autonomy support given by the entire environment and was used as a reference for BNSG which was used to measure need satisfaction with the focus on the mobile app. A summary of the paired-sample *t*-test is shown in **Table 5** below.

Although participants' self-perceived autonomy support measured by BNSG decreased, this overall measure had a

TABLE 4 | Summary of participants' basic needs satisfaction.

	Pre-test		Post-test		95% CI for mean difference				Cohen's *d*
	M	SD	M	SD	*N*	*t*	df	Sig. (two-tailed)	
Autonomy	4.79	0.38	4.42	0.41		2.39		0.04	–0.72
Competence	4.58	0.44	5.24	0.82	11	–3.01	10	0.01	0.91
Relatedness	5.13	0.34	5.65	0.64		–2.62		0.03	0.79

significant increase, from 4.17 to 4.71 on average [$t(10) = -6.58$, $p < 0.001$]. The Cohen's effect size value ($d = 1.98$) of this change suggested a high practical significance. However, the score is not very high in a 7-point Likert scale. This suggests that the overall learning context is pretty autonomy supportive, though the use of *myUniMate* let participants feel less autonomy supported.

Academic Motivation

The "Academic Motivation Scale" was used to assess participants' motivation toward learning. A summary of the comparison between the pre-test and post-test data is given in **Table 6** below.

From the beginning of the study, the participants already have a positive academic motivation, as the mean score of the first six motivation categories are all above 3.5 (half of full mark, 7) and the AM category received a score of 1.48 which was very low. Specifically, the IM categories (To know, Toward accomplish, and To experience stimulation) and the EM categories (Identified, Introjected, and External regulation) were both positive. The IM "to experience stimulation" was relatively low, which was 3.91, compared to the other two categories, 5.25 and 5.00. Similarly, the introjected external motivation was low compare to the other two external motivation categories, Identified and External regulation, being 3.77 out of 7.

After the app-usage period, all three IM categories had a statistically significant increase. IM "to know" increased from 5.25 to 5.57 [$t(10) = -2.43$, $p = 0.04$] with a Cohen's effect size value of $d = 0.73$. This suggests a moderate to high practical significance. IM "toward accomplishment" increased from 5.00 to 5.77 [$t(10) = -4.09$, $p = 0.02$]. The Cohen's effect size value ($d = 1.23$) suggests a high practical significance. Similarly, IM "to experience stimulation" increased from 3.91 to 4.91 [$t(10) = -5.16$, $p < 0.001$] and its Cohen's effect size value ($d = 1.56$) suggests a high practical significance.

From the qualitative feedback given by the participants, we also observed a strong motivation in learning. Some participants expressed external drivers of their motivation, such as jobs and salary. For example, P-10 commented that "I've always wanted to know wether [whether] my bachelor/major is easy to find a job or not" and p-12 commented that "[I would like to know] how much I can earn after graduate… [and] what is the salary trend for my profession." The motivations expressed by the other participants were more intrinsic with a focus on learning. For example, P-4 commented that "[I would like to know] how our courses go in the future" and P-5 commented that "[I would like to know] which unit of study and which lecture of that unit is good."

Learning Approaches

As can be seen from **Table 7**, no statistically significant differences were observed in terms of learning approaches. However, participants expressed a preference in deep approaches in terms of learning in their comments. When asked how the participants were planned to study, P-9 gave the answer "follow the instructions, do what I am asked to do, and learn new things while practicing." This answer shows the initiative that the participant would like to take, which include a feedback loop. This way of learning is of the deep learning approaches. Similarly, P-4 answered "accumulate knowledge through practicing, staring from familiarizing with contents and work on exercises with gradually increasing difficulties. I'm still trying to find the best way but this might work for me just now.," which is a more specific learning plan. These comments echo well with the quantitative analysis on the R-SPQ-2F data.

DISCUSSION

The increase in the engagement of *myUniMate*, students' self-perceived competence support and different learning motivation, together with positive comments on different components of the app, indicate that *myUniMate* is another step toward a better way of transition support. However, the app still needs to be better tailored to suit students' needs even when it was designed following an UCD approach.

Autonomy Support

In the education domain, being autonomous has long been considered as one of the properties of a quality learner (Dickinson, 1995), and specifically, an autonomous learner tends to have a higher motivation and will have better and more effective work. The support of autonomy is normally provided by the course

TABLE 5 | Summary of participants' perceived autonomy support.

	Pre-test		Post-test		95% CI for mean difference				Cohen's *d*
	M	SD	M	SD	*N*	*t*	df	Sig. (two-tailed)	
LCQ	4.17	0.39	4.71	0.47	11	−6.58	10	<0.001	1.98

TABLE 6 | Summary of participants' academic motivation.

Academic motivation categories	Pre-test		Post-test		95% CI for mean difference				Cohen's *d*
	M	SD	M	SD	*N*	*t*	df	Sig. (two-tailed)	
To know	5.25	0.74	5.57	0.61	11	−2.43	10	0.04	0.73
Toward accomplishment	5.00	0.50	5.77	0.83		−4.09		0.002	1.23
To experience stimulation	3.91	0.67	4.91	0.63		−5.16		<0.001	1.56
Identified	6.36	0.66	6.59	0.56		−1.46		0.18	0.44
Introjected	3.77	0.83	3.70	0.78		0.48		0.65	−0.14
External regulation	6.52	0.38	6.36	0.55		0.81		0.44	−0.24
Amotivation	1.48	0.34	1.64	0.52		−1.17		0.27	0.35

TABLE 7 | Summary of participants' learning approaches.

	Pre-test		Post-test		95% CI for mean difference				Cohen's *d*
	M	SD	M	SD	*N*	*t*	df	Sig. (two-tailed)	
Deep motive	16.82	3.89	19.00	2.90	11	−1.75	10	0.11	0.53
Deep strategy	12.00	1.55	13.18	3.03		−1.49		0.17	0.45
Surface motive	8.64	1.69	10.55	3.93		−1.32		0.22	0.40
Surface strategy	12.09	1.76	12.27	2.28		−0.33		0.75	0.10

lecturers and the teaching methodologies that they use, for example, the flipped-classroom approach (King, 1993) supports students' autonomy as its various implementations require students to prepare themselves with materials before lectures take place and instead of one lecturer dominating the classroom, students are normally encouraged to ask questions and start discussions during a flipped-classroom lecture. On the other hand, autonomy support that is provided by software is hard to design, as different design approaches would affect one's motivation differently, and even a subtle wording difference on the software could result in different perceptions of the software itself. What is worse, the differences in design are impossible to be quantified. The only thing we can do is trial-and-error.

When trialing the previous version of *myUniMate*, the researchers were in charge of the entering and deleting of entries in the "Task Tracking" component, and the participants requested more freedom in the use of that component (Zhao and Pardo, 2015). However, in the trial of the current version of *myUniMate*, participants were given full access to add, update, and delete entries in the "Task Tracking" component. Instead of the expected one-sided positive comments, they still want more. One example comment from P-10 is "I think our classes and each assignment should be [automatically added] to the calendar, it will be more clear [clearer] for students to check their time." The most obvious suggestion of this comment is that the students need something in the middle of fully controlled and fully autonomous functions on the app.

Based on the results of BNSG and LCQ, we concluded that *myUniMate* had a negative influence on the participants' self-perceived autonomy support, which is an interesting finding. As no comments directly point us to the reason of this result, we consider the most probable cause of this result to be the use of notifications to deliver reminders and suggestions to the students. During the first questionnaire session, we purposefully instructed the participants to use *myUniMate* in ways that they prefer, which means they could stop using it whenever they wanted to. Therefore, there is a good chance that the negative influence was caused by the notification which the participants could not stop. Further study is needed to have a clear answer to this question.

Discussion Board and Information Presentation

As explained in Section "The Design of the *myUniMate* App," the Connectedness sense and the Resourcefulness sense of the "5 Senses Model" were indirectly supported in the app. Based on the responses of the post-study questionnaire, both senses are proved to be integral parts of transition support, which in turn emphasized that the "5 Senses Model" can also be used as a guide in designing software tools to support transition to tertiary education.

Specifically, in terms of Connectedness, different social features were proposed by participants. P-6 mentioned, "…Secondly, [the feature] might [could] be socializing features to connect the users via tagging themselves with interests. Also maybe working as a[n] announcement board for local events as well." Similarly, P-8 mentioned that "[a] discussion board [could be implemented] so that users can help each other." From the above-listed comments, two points should be noted:

1. Social-related features should not replace in-person socialization, which resonances with our design decision mentioned in Section "The Design of the *myUniMate* App."
2. Tools such as discussion board or chat rooms can be used as tools to provide peer-support that is available within a single mouse-click or a few key strokes.

As to the Resourcefulness sense, only limited course-related information was available in *myUniMate*, and no instructions or guidelines for navigating the university information system were provided by the research group during the field trial. However, there is a strong need to such information from the participants, especially for the information about their degree and future development, which is consistent with our previous study. As commented by P-9, "[I would like to know], which unit of study and which lecture [course] of that unit is good." P-10 mentioned, "I've always wanted to know wether [whether] my bachelor/major is easy to find a job or not." And P-11 mentioned, "[I want to know] how much I can earn after I graduate, and how hard I need to work in order to get a role [job] that I want." According to the SDT (Deci and Ryan, 1985, 2000; Deci et al., 1999; Ryan and Deci, 2000), the more information one has about the current context and the more one understands the current context, the most likely she/he will be autonomous, and thus more likely to have a better psychological well-being. Therefore, provision of such information is important in supporting educational transitions and should be listed as future works.

Need for Personalized Feedback

Although a Notification component was implemented in *myUniMate*, all notifications sent during the field trial period was common among all participants. However, notifications or feedbacks tailored to individual's needs are always preferred. P-2 mentioned that "regularly providing personalized feedback would make more sense since we are entering a lot of information." P-3

had a similar comment, "notifications should be personalized, otherwise [the notification component is] useless." This echoes with the results reported in previous studies (Brinkworth et al., 2009; Crisp et al., 2009; Thalluri and King, 2009).

We consider transition to tertiary education as a special case of behavior change, which have been studied extensively in the field of HCI, Persuasive Technology, and Pervasive Computing. Therefore, mechanisms proved useful in supporting behavior change could be applicable in the supporting of transition to tertiary education. The personalized notification mentioned in the previous paragraph can then be generalized to tailored interventions which is widely used in the support of behavior change. Goal setting theory should also be considered in future versions of *myUniMate*.

Integrating Multiple Devices

In this study, *myUniMate* was implemented as a mobile application that is able to function on its own, and no other widely used software applications were integrated into *myUniMate*, which is one of the limitations of this study. P-5 mentioned in the post-study questionnaire that "[*myUniMate* should] be a good hub and leave the function implementation to the other apps rather than do everything in one.," and a specific example was given by P-10, "[*myUniMate* should] import or sync data with other calendar & todo app[s]." Integration with Google Calendar and iOS Calendar was considered when designing *myUniMate*, but since one of our design goals was to make *myUniMate* self-contained with no dependency on other platforms in the field trial, we decided not to implement the integration. However, we do admit that an integration with various widely used tools is a must in the production version of the *myUniMate* app. As suggested by the quantitative results of R-SPQ-2F, *myUniMate* had no influence on participants learning approaches. This is an expected result since apart from information entered by the participants, the app did not have built-in support of learning. In order to integrate the support of learning into *myUniMate*, a connection with existing learning management systems should be built.

In the context of transition support, providing only one mobile application as the source of support could be another limitation, as mobile phones are not designed to be used in all conditions. The most obvious feature (or limitation) of mobile phones is their much smaller screen sizes compared to computers. When displaying charts within the Feedback component, only two charts are able to fit into the screen, however, on a computer, not only more charts can fit into the screen, but more sophisticated interactions or data manipulations can be performed.

The transition to tertiary education plays a crucial role in students' overall success. Even though educational institutions have designed and implemented various transition support programs, most of them are underutilized. With the high adoption rate of smart phones among university students, mobile applications can be used as a media of personalized support throughout the transition. In this paper, we presented the design and implementation of *myUniMate*, a mobile application that aims at providing transition support to first year university students. The field trial result showed that the mobile application was able to positively alter students' self-perceived competence and relatedness, and improve their IM of learning. However, although the overall learning context was autonomy supportive, the mobile application was shown to have a negative influence on students' self-perceived autonomy. Possible improvements and future works were discussed.

ETHICS STATEMENT

This study was approved by the University of Sydney Human Ethics Research Committee (protocol 2015/473). All participants gave written informed consent before the study.

AUTHOR CONTRIBUTIONS

YZ has contributed to the software development, recruitment, data gathering, data analysis, and writing. AP has contributed to the recruitment, data analysis, and writing.

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