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Reflecting on personal data in a health course: Integrating wearable technology and ePortfolio for eHealth

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Activity trackers (ATs) equipped with biometric sensors may support deep knowledge acquisition of health and active learning. The mechanism may be via personal data being pushed to the students, which deepens the knowledge about their own health and may impact long-term health action processes. To understand health knowledge acquisition, 43 students attending an undergraduate university course were equipped with an AT over a period of five months. Weekly observation on emerging personal data and consequent actions (lifestyle adaptations) were reflected in an individual course-related ePortfolio. Students' change in health action process was assessed using a short standard eHealth literacy scale at the beginning and end of the course. The usability of ePortfolio tool was tested with two previously validated scales. The combination of personal information from an AT and ePortfolio may have enhanced students' critical assessment of health-related personal and available digital information. eHealth literacy scores significantly increased by the end of the course ($p < .01$). The ePortfolio helped with learning, and the usability of the ePortfolio did not really interfere. The combination of AT and ePortfolio constitutes a novel and productive method of using ePortfolios in higher education in regards to eHealth literacy acquisition.

Introduction

Wearable technologies (e.g., wrist-worn activity trackers, ATs) may improve actual physical health. They may also contribute to greater eHealth, which is "the use of emerging mobile communications in public health designed to change health behaviours and health care" (Descatha et al., 2016). However, research to date has not established what determinants of wearable technology have an impact on individual behaviours related to actual health. This study contributes to the field by having students reflect on their own AT data and integrate that into an ePortfolio system as part of a higher education course on physical activity. Thus, this paper reports an innovative application of wearable technology in a classroom research setting and tests for positive effects in a curriculum setting, a research direction previously suggested (Borthwick, Anderson, Finsness, & Foulger, 2015). It is the combination of AT with other technology systems (ePortfolio), curricular innovations (integration of online personalised data), and individual monitoring (eHealth literacy self-reports) that seems to create an impact.

Wearable technology

Wearable technologies, such as an AT, deliver specific situated information to the learner. A student wears an AT for over a period of many months, and receives situated, personalised information which is pushed to their smartphone. The app used shows the evolution of activity, sleep, and heart rate over days, weeks, and months. The person wearing the technology has to effectively use tools and resources from the Internet and other media channels that are associated with the AT system (e.g., data display interfaces on smartphones). Such interactions may help learners become more aware of and critical about the health-related information they encounter from other sources in light of their own experiences. Ridgers, McNarry, and Mackintosh (2016) have suggested that AT data may motivate student goal setting as well as feedback to users from the researcher or tutor.

Thus, wearable technology can be linked to learning concepts and instructional methods like knowledge building, and situated, self-regulated, and active learning. In situated learning, meaning is extracted from a real daily activity leading to learning by connecting prior knowledge to new contexts (Brown & Duguid, 1998). Furthermore, a student who is metacognitively, motivationally, and behaviourally engaged in his or her own learning processes and in achieving his or her own goals, seems to have greater ownership of learning (Shroff & Vogel, 2009; Zimmerman & Schunk, 2008), although this depends on finding personal value in and taking responsibility during the learning process (Armitage, Wilson, & Sharp, 2004). In order to find personal value, students need to be involved in the studied topic, realising the application of the acquired knowledge outside the learning situation (i.e., in real life). Active learning refers to any instructional method that engages students in the learning process (Bonwell & Eison, 1991), by requiring them to do meaningful learning activities and to reflect upon what they are doing.

eHealth

Specifically, eHealth literacy is "the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem" (Norman & Skinner, 2006b). eHealth literacy encompasses the ability to work with technology, think critically about issues of media and science, and navigate through a vast array of information tools and sources to acquire the information necessary to make informed decisions (Norman & Skinner, 2006a). eHealth literacy is often underdeveloped among students in higher education (Stellefson et al., 2011). The quality of individual eHealth literacy is commonly evaluated with a short, standardised scale developed by Norman and Skinner (2006a). This scale has been validated for multiple languages, including Chinese (Koo, Norman, & Hsiao-Mei, 2012).

The association between perceived and performed eHealth was recently described as being moderately correlated, and digital literacy and eHealth literacy as highly correlated (Neter, Brainin, & Baron-Epel, 2017). They therefore suggested differentiating between digital literacy and eHealth literacy skills. Lower health literacy in general is associated with poorer health and lower self-management (Sukys, Cesnaitiene, & Ossowsky, 2017). Furthermore, certain lifestyle determinants, such as physical exercise, has been described to be strongly and positively associated with eHealth literacy, at least in some recent studies (Xesfingi & Vozikis, 2016); hence this topic should be important from the public health perspective.

eHealth and wearable technology

Few successful attempts have been made to demonstrate whether wearable technology alone has an impact on individual behaviours related to actual health. Kim, Lumpkin, Lochbaum, Stegemeier, and Kitten (2018) found null effects of utilising the wearable AT in promoting physical activity in college students, suggesting that just using the wearable AT as a behaviour change strategy may not be effective in increasing physical activity. Chung, Skinner, Hasty, and Perrin (2017) found that healthy lifestyle changes and potential weight loss occurred through a combination of social interaction and person-generated health data from wearables. Schaben and Furness (2018) have suggested that the AT should be combined with other intervention approaches such as goal setting and researcher feedback. Bus, Peyer, Bai, Ellingson, and Welk (2017) suggested that coaching (online or personal) in addition to ATs promotes behaviour change, which might justify or support the use of a feedback and coaching tools like ePortfolio. Thus, rather than simply providing a fitness tracker, self-monitoring in combination with a number of other effective techniques may be needed to improve the overall health and well-being of college students.

Nonetheless, the presence of the AT as a data source seems very useful. The AT provides a personalised platform of needs and experiences that could lead to subsequent eHealth behaviours (e.g., search, modification, and application of strategies) (Gulikers, Bastiaens, & Martens, 2005). This leads to the development of eHealth literacy, which in turn ought to motivate the long-term development of general health-related behaviour. The systematic review on eHealth literacy among college students (Eysenbach & Group, 2011) suggests a need to further identify and develop technological tools to improve eHealth. We postulate that the development of eHealth literacy could be enhanced through not just wearing an AT, but also through considered reflective and critical thinking as part of a curriculum initiative and captured through an ePortfolio (Kong, Shroff, & Hung, 2009). This interaction between personalised physical activity data and an ePortfolio reflection system could contribute to the development of eHealth. However, there is little research on using a combination of personal data and ePortfolio. One particular feature of the wearables was employed in the design of this study: the AT provides information on the individual's health action decision making and motivation to cope with potential difficulties during the health action process (Schwarzer, 2008). The novelty of our study lies in addressing this knowledge gap, demonstrating how students' personal data delivered via AT, in combination with an ePortfolio system, influences eHealth literacy, in an undergraduate health-related course at the University of Hong Kong, China.

ePortfolio use in higher education

ePortfolio use appears to help students in academic learning (Mohammed, Khadija, Mohammed, & Abdelouahed, 2015), raise their self-awareness and reflection (Belcher et al., 2014; Gülbahar & Tinmaz, 2006) and promote lifelong learning (Rees & Sheard, 2004). From within the wide array of definitions and interpretations of ePortfolio (Hallam & Creagh, 2010), this study defines ePortfolio as "a purposeful aggregation of digital items – ideas, evidence, reflections, feedback – which presents a selected audience with evidence of a person's learning and/or ability" (Powell, 2007). The most attractive aspect of using an ePortfolio in this study is its support for reflective and critical thinking (Kong et al., 2009). It allows academic advisors to give consultative feedback and helps students to develop skills including recording, selecting useful information, and annotating documents in their career later in life (Brown, Irving, & Keegan, 2007; Cheung, 2012). Hence, the ePortfolio adopted in this study was a personal digital collection of artefacts (e.g., course readings, websites, AT data) organised in a purposeful way to assess growth over time and which was scaffolded through continuous formative feedback.

A study with Hong Kong University students found that having a positive attitude towards ePortfolio use led to positive views about ePortfolios as contributing to assessment for learning, suggesting that a positive experience with the ePortfolio in this study would lead to better learning (Deneen, Brown, & Carless, 2017). The ePortfolio was continuously assessed using a rubric, provided at the beginning of the semester.

The intention of the investigators was to integrate a scaffolded student-teacher collaboration and dialogue in an ePortfolio, with personalised data derived from activity beyond the classroom (via an AT) to achieve critical assessment of personal and online information. This, in turn, was expected to enhance deeper learning of the health course objectives and stimulate self-directed inquiry and greater eHealth literacy.

Research hypothesis

The overall goal of the study was to personalise students' eHealth acquisition with data from their own AT; students were required to reflect within an ePortfolio on the relationship of their own experience to the research literature on physical health. It was expected that the students would inspect the record of their own actual physical activity AT data, in light of the course goals, and consequently arrive at personal health information needs (Figure 1). Subsequently, the students were expected to record the information they found in response to their personal health needs and compose a reflection on their observations and conclusions. The AT-recorded physical activity continued the loop, accumulating more data. Each recorded ePortfolio reflection was reviewed and commented on by the course tutor. It was expected that these activities would enhance critical literacy, raise concerns about health-related topics, and stimulate further inquiry, leading to higher eHealth literacy and personalised health actions.

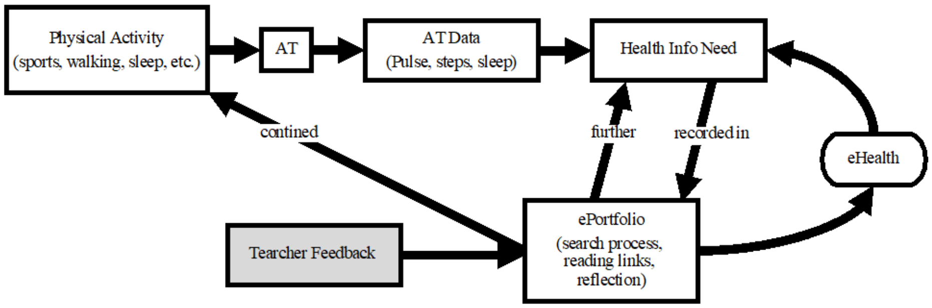


Figure 1. Learning process pathways involving an AT and ePortfolio

Methodology

The research setting

Data were collected, with permission, from students (*n* = 43) enrolled in a single semester (i.e., 12 weeks of instruction) undergraduate course, entitled “Physical Activity (PA) and Health”, which was taught during the second semester of the 2015-2016 academic year at the University of Hong Kong. One of topics of this course was wearable technology interventions and eHealth literacy. The students were required to weekly document their reflections on health-related actions using their personal AT data. Permission to conduct this study was obtained from the University of Hong Kong Committee of Ethics.

The sample size was sufficiently large for a multi-case study (Savolainen, 1993). The questionnaire data were collected by the teaching assistants and the AT (individual reflections and biometric data) were recorded into the ePortfolio. The project design, the sequence of data collection, and the relevant research questions are shown in Figure 2.

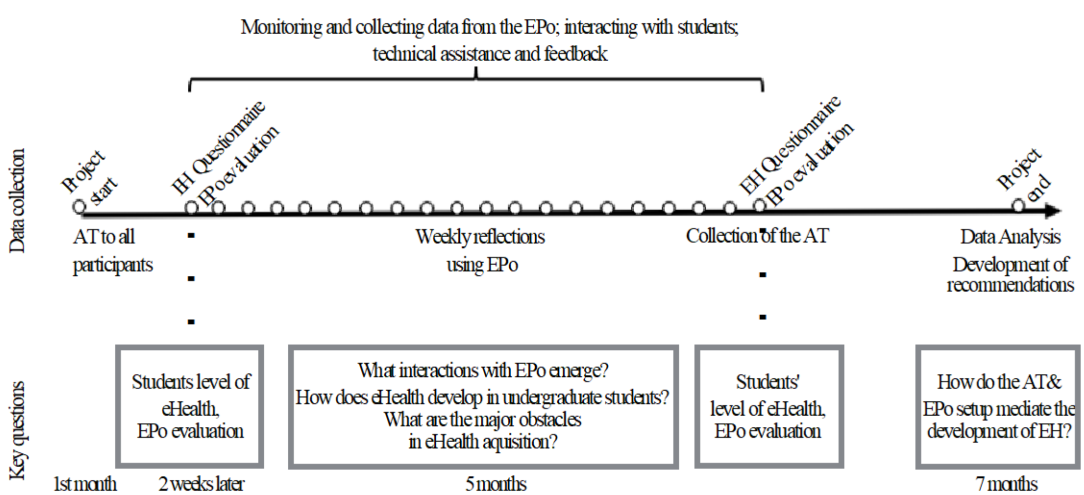
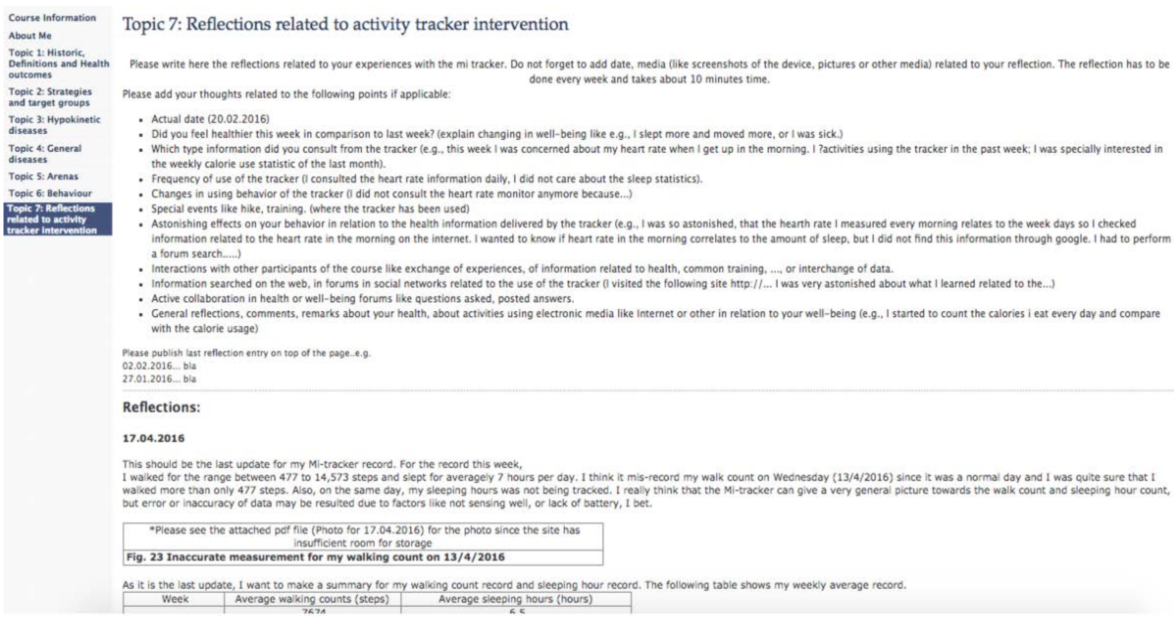


Figure 2. Project flow diagram (AT – activity tracker; EPo – ePortfolio; EH– eHealth)

Technology and the ePortfolio setup

Google Sites was chosen as the ePortfolio technical platform for a number of reasons. Firstly, Google Sites is a ubiquitous platform, available outside the University and providing the possibility to create a simple, course-specific template accessible to all the students, regardless of their level of technical competence and comfort. Google Sites enables organising, storing of personal information, and uploading of different kinds of digital information, with links to resources, films, pictures (San Jose, 2017). Secondly, Google Sites also allows reorganisation or change in the structure, thus potentially allowing identification of improvements during the entire learning process. Thirdly, Google Sites gives the user (the students) a complete sense of ownership over the content and structure of the ePortfolio.

As a result, a typical ePortfolio was a student collection of evidence that potentially showed the trajectory of the student's learning. Clear step-by-step instructions, including how to set up the ePortfolio and share it with the course instructor and tutors, were provided on the first day of the course (Figure 3). An IT technician was in the class to support the students who had problems in setting up the ePortfolio. Some outstanding ePortfolios from students in a previous course were shown as examples. The instructor and tutors provided technical assistance throughout the whole term via email and in person.


Course Information
About Me
Topic 1: Historic, Definitions and Health outcomes
Topic 2: Strategies and target groups
Topic 3: Hypokinetic diseases
Topic 4: General diseases
Topic 5: Arenas
Topic 6: Behaviour
Topic 7: Reflections related to activity tracker intervention

Topic 7: Reflections related to activity tracker intervention

Please write here the reflections related to your experiences with the mi tracker. Do not forget to add date, media (like screenshots of the device, pictures or other media) related to your reflection. The reflection has to be done every week and takes about 10 minutes time.

Please add your thoughts related to the following points if applicable:

- Actual date (20.02.2016)
- Did you feel healthier this week in comparison to last week? (explain changing in well-being like e.g., I slept more and moved more, or I was sick.)
- Which type information did you consult from the tracker (e.g., this week I was concerned about my heart rate when I get up in the morning. I ?activities using the tracker in the past week; I was specially interested in the weekly calorie use statistic of the last month).
- Frequency of use of the tracker (I consulted the heart rate information daily, I did not care about the sleep statistics).
- Changes in using behavior of the tracker (I did not consult the heart rate monitor anymore because...)
- Special events like hike, training. (where the tracker has been used)
- Astonishing effects on your behavior in relation to the health information delivered by the tracker (e.g., I was so astonished, that the hearth rate I measured every morning relates to the week days so I checked information related to the heart rate in the morning on the internet. I wanted to know if heart rate in the morning correlates to the amount of sleep, but I did not find this information through google. I had to perform a forum search.....)
- Interactions with other participants of the course like exchange of experiences, of information related to health, common training, ..., or interchange of data.
- Information searched on the web, in forums in social networks related to the use of the tracker (I visited the following site http://... I was very astonished about what I learned related to the...)
- Active collaboration in health or well-being forums like questions asked, posted answers.
- General reflections, comments, remarks about your health, about activities using electronic media like Internet or other in relation to your well-being (e.g., I started to count the calories i eat every day and compare with the calorie usage)

Please publish last reflection entry on top of the page..e.g.
02.02.2016... bla
27.01.2016... bla

Reflections:

17.04.2016

This should be the last update for my Mi-tracker record. For the record this week,
I walked for the range between 477 to 14,573 steps and slept for averagely 7 hours per day. I think it mis-record my walk count on Wednesday (13/4/2016) since it was a normal day and I was quite sure that I walked more than only 477 steps. Also, on the same day, my sleeping hours was not being tracked. I really think that the Mi-tracker can give a very general picture towards the walk count and sleeping hour count, but error or inaccuracy of data may be resulted due to factors like not sensing well, or lack of battery, I bet.

*Please see the attached pdf file (Photo for 17.04.2016) for the photo since the site has insufficient room for storage
Fig. 23 Inaccurate measurement for my walking count on 13/4/2016

As it is the last update, I want to make a summary for my walking count record and sleeping hour record. The following table shows my weekly average record.

Week	Average walking counts (steps)	Average sleeping hours (hours)
	7674	6.5

Figure 3. Instructions and a sample entry in the ePortfolio

Students were encouraged to update their ePortfolio weekly and to weekly reflect on their use of the AT. The participants entered their biometric data (e.g., heart rate, number of steps, and sleep hours), lifestyle adaptations (e.g., more sleep), and special circumstances related to the data (e.g., going on a hike up a steep incline which changed their heart rate). Additionally, they recorded how this data and related experiences led to any specific online search, their readings and reflections as well as their behaviours in real life and on social network platforms. The students were able to publish different formats of reflections as text and use hyperlinks to health-related web pages and images. The students had access to all their reflections and could retrieve their previously documented events in their final reflective ePortfolio.

Measurement scales

eHealth assessment

The main outcome, eHealth literacy acquisition, was recorded by a questionnaire in a pre- and post-test design. It addressed the research question as to whether students' eHealth literacy changed during the course. It was presumed that any changes in eHealth would be enhanced by the combination of AT and ePortfolio, though the design did not allow a strong causal association. A well-established questionnaire (eHEALS) was adopted for the purpose of investigating changes in eHealth literacy (Norman & Skinner, 2006). The scale focuses on knowledge about Internet health resources, how to access and evaluate them, and confidence in using this Internet knowledge for health decisions. The scale has been shown to be internally consistent (i.e., Cronbach alpha = .94) and stable (i.e., no statistically mean score difference in a test-retest condition; $t_{[244]} = -1.48$, $p = .14$) (Chung & Nahm, 2015).

ePortfolio evaluation

To evaluate the ePortfolio as a tool, two different previously validated scales were used: (a) the student perceptions of its learning benefits were measured using a validated questionnaire with 11 items (Hoekstra & Crocker, 2015) and (b) the students perceptions of how usable the ePortfolio system was measured by the usability test employing a 10-item set of items (Brooke, 1996). The items focus on how easy it is to use the system, how confident the user is in using the system, and the attractiveness of the system.

Finally, the student perceptions of ePortfolios as an assessment tool were evaluated by the Chinese student conceptions of assessment inventory (Deneen et al., 2017). A Chinese version of this inventory which has gone through extensive development and norming in Hong Kong and the People's Republic of China, has eight factors and 29 items (Brown & Wang, 2016). Three factors with all their relevant items were selected. Four items referring to assessment improving class climate were adapted to refer to group benefits. Seven items referring to the negative aspects of assessment were modified to focus on journal articles, rather than books. Two items referring to teacher use of assessment to track progress and plan teaching were retained with the insertion of the term ePortfolio.

It is worth noting that each student's AT data and any changes in actual physical activity were not captured as this was used only as a means to help the students reflect on and develop their personal eHealth. Hence, this paper reports only on the outcomes captured in the eHealth questionnaires and ePortfolios themselves. Nonetheless, the presence of the AT data did provide personal motivating data for the study.

Data analyses

Firstly, the structure of the questionnaires was tested. To determine the dimensionality of the eHealth literacy questionnaire, a confirmatory factor analysis (CFA) was conducted. Given the sample size and number of items involved, it was expected that a single factor could be obtained (Marsh, Hau, Balla, & Grayson, 1998). On the other hand, the ePortfolio questionnaire, with 34 items, was submitted first to dimensionality analysis (Courtney, 2013), which suggested two or three factors would fit the data. Exploratory factor analysis (EFA) – maximum likelihood estimation and oblique rotation (Osborne & Costello, 2004) – suggested a two-factor solution fit the data best, which was further tested in CFA.

The quality of a model is determined by the inspection of a number of fit statistics (Hu & Bentler, 1998). Not all indices are equally stable across variations in sample size, model complexity, or model misspecification (Fan & Sivo, 2007; Marsh, Hau, & Wen, 2004). Consistent with contemporary standards, models that met the following criteria were not rejected: comparative fit index (CFI) and gamma hat >.90; root mean square error of approximation (RMSEA) and standardised root mean residual (SRMR) <.08; and statistically non-significant ratio of χ^2/df (i.e., $p > .05$).

In the event of unacceptable fit, strong modification index values can indicate items that are causing disturbance through having highly correlated residuals with other items, having statistically significant loadings to other items, and having loading values < .50. Removal of such items can improve fit and a judgment needs to be made as to whether the remaining items still produce a meaningful measure of the intended construct.

Secondly, after establishing acceptable measurement models, scale scores were created by averaging the response scores for each item belonging to the factor. Differences in self-reported scores between time 1 and time 2 (Figure 2) were evaluated using one-way ANOVA and matched *t*-tests. Correlations were used to explore the relationship of scales to each other.

Results

eHealth literacy

A single-factor model of all 8 items had unacceptable fit (χ^2 = 131.43; *df* = 20; χ^2/df = 6.57, *p* = .01; CFI = .80; RMSEA = .25; gamma hat = .76; SRMR = .082). Two items (EH5 "I know how to use the health information I find on the Internet to help me"; EH7 "I can tell high-quality from low-quality health resources on the Internet") had strong inter-correlations to other items and were removed, producing acceptable fit (χ^2 = 30.51; *df* = 8; χ^2/df = 3.39, *p* = .07; CFI = .94; gamma hat = .92; RMSEA = .17; SRMR = .054). Standardised regression weights for the six retained items are shown in Table 1.

Table 1
eHealth literacy standardised regression weights

Item	Statement	λ
EH3	I know how to find helpful health resources on the Internet	.93
EH2	I know where to find helpful health resources on the Internet	.92
EH4	I know how to use the Internet to answer my health questions	.79
EH1	I know what health resources are available on the Internet	.78
EH8	I feel confident in using information from the Internet to make health decisions	.65
EH6	I have the skills I need to evaluate the health resources I find on the Internet	.62

Mean scores were created by averaging the response value to the six items. Matched *t*-test found statistically significant differences in mean between before (*M* = 3.77, *SD* = .58) and after (*M* = 4.48, *SD* = .74) using the ePortfolio, ($t_{(1, 43)}$ = 5.98, $p < .001$; *r* = .30; *d* = 1.07). The results revealed that students believed they knew more about eHealth after participating in the course.

A scatterplot of eHealth literacy scores before and after the course indicated that the trend of improved eHealth literacy was almost universal (Figure 4).

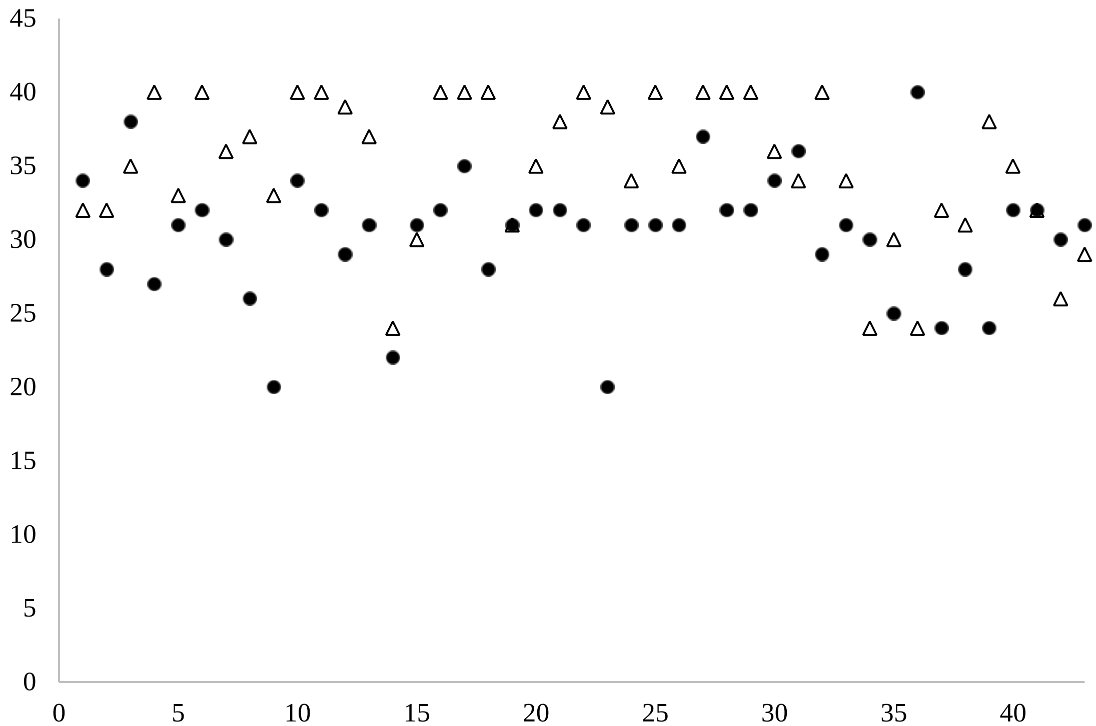


Figure 4. Pre eHealth (●) and post eHealth (△) literacy results

Evaluation of ePortfolio

ePortfolio for learning

The 11 items of the Hoekstra and Crocker ePortfolio learning scale were tested in a CFA as a single factor. Deletion of one item (EP 20) produced a robust fitting scale ($\chi^2 = 45.06$; $df = 35$, $p = .12$; $\chi^2/df = 1.29$, $p = .26$; CFI = .96; gamma hat = .96; RMSEA = .08 (90%CI = .00-.15); SRMR = .056). Paired *t*-test ($t_{(43)} = 5.47$, $p < .001$; $r = .71$) indicated that there was a statistically and practically significant increase in learning benefits from ePortfolio mean scores ($\triangle M = 0.54$; $SD = .66$; $d = .63$).

Relying on a coarser grained approach, the responses were dichotomised with three or more classified as agreement. Of 10 items, seven had positive shifts in the number of participants indicating positive endorsement of the items. The increases ranged from trivial (EP21, EP23) to moderate (EP1) (Table 2). The agreement rate concerning interaction between teachers and students shifted between time 1 and time 2 (Table 2) from 28/43 to 36/43 ($d = .59$), suggesting that the ePortfolio contributed to improved learning communication between faculty and students (Table 2). Three items recorded decreased agreement, though these differences ranged from trivial (EP16) to small (EP24, EP19).

Table 2
Students' endorsement of ePortfolio learning functions before and after the course

Measure	Before	After	Effect size (*d*)
EP1. Interaction between teacher and me	28	36	0.59
EP18. Learn better	28	34	0.42
EP17. More enjoyable in learning	21	27	0.36
EP22. Self-learning tool (use it in future)	19	25	0.35
EP15. Facilitation of feedback	31	35	0.31
EP21. Evaluation of my own work	31	38	0.06
EP23. Professional development (learning)	25	26	0.06
EP16. Interest in subject	31	28	-0.19
EP24. Set learning goals	31	26	-0.32
EP19. Learn continuously	37	33	-0.35

ePortfolio as assessment
The EFA of the ePortfolio assessment items suggested three factors existed among the 13 items. Within CFA, three items were removed because they did not have strong on-factor loadings or had strong cross-loadings to other items or factors. The 8-item, 3-factor solution (Table 3) had good fit ($\chi^2 = 29.96$; $df = 25$, $p = .23$; $\chi^2/df = 1.20$, $p = .27$; CFI = .97; gamma hat = .92; RMSEA = .068 (90%CI = .00-.15); SRMR = .096). The first factor, *ignore*, captured the idea that ePortfolio results were ignored ($M = 1.92$, $SD = 1.07$), the second, *group climate*, was the beneficial effect on group climate by having to work on ePortfolio assessment ($M = 4.22$, $SD = 1.06$), and the third, *limitations*, spoke to the limitations of the ePortfolio assessment system ($M = 3.07$, $SD = 0.93$). The mean scores for each factor clearly indicated that students chose not to ignore the ePortfolio assessment and that it was a positive experience within their groups. Opinions were somewhat more mixed in terms of its limitations.

The inter-correlations were generally weak but logically ordered. *Ignore* was inverse to *group climate* experience ($r = -.27$, $p = .04$) suggesting that if the ePortfolio improved the group climate it was not ignored. At the same time 'Ignore' was positively correlated with *limitations* ($r = .36$, $p < .01$), indicating that ePortfolios might be ignored if they were seen as limited in scope. In contrast, *limitations* and *group climate* were very weakly but positively correlated ($r = .11$, $p = .24$), although this value is statistically not significant, meaning that these two factors are independent rather than positively associated.

Table 3
ePortfolio as assessment items and factor loadings

Code	Item	Factor: Ignore	Factor: Group climate	Factor: Limitations
EP12	eP assessment results are noted & ignored	0.99		
EP10	I ignore my eP assessment results	0.61		
EP4	eP assessment encourages my group to work together and help each other		0.98	
EP5	eP assessment makes our group cooperate more with each other		0.99	
EP3	Our group becomes more supportive when our ePs are assessed		0.88	
EP14	Teachers use my eP assessment results to see what they need to teach me next		0.57	
EP7	eP assessments only focus on journal learning and knowledge			0.85
EP6	eP assessment is limited to what can be learned in journals			0.76
EP9	My classmates and peers are better at eP assessments than I am			0.36

Note. eP = ePortfolio; all values are standardised beta values.

ePortfolio usability

The 10 usability items were reduced to two scales (*ePortfolio is easy to use* and *I need help to use the ePortfolio*) with seven items and had a good fit ($\chi^2 = 16.63$; $df = 13$, $p = .22$; $\chi^2/df = 1.28$, $p = .26$; CFI = .97; gamma hat = .92; RMSEA = .081 (90%CI = .00-.18); SRMR = .057). The inter-correlation was weak and not statistically significant ($r = -.10$), suggesting that the two factors co-existed independently. The *easy to use* factor had a relatively positive mean ($M = 4.15$, $SD = 0.98$), while the *need help* factor had a much lower mean ($M = 2.79$, $SD = 1.01$). The low mean score for needing help indicates that the ePortfolio was fundamentally easy to use because the contributing items point to negative facets of the system (i.e., inconsistency in the system (EP30), need for technical support (EP28), and need to learn prior to using (EP34).

Table 4
ePortfolio usability items and factor loadings

		Factor	
Code	**Item**	**Easy to use**	**Need help**
EP29	I found the various functions in this eP were well integrated	0.85	
EP31	I would imagine that most people would learn to use this eP very quickly	0.80	
EP33	I felt very confident using the eP	0.77	
EP27	I thought the eP was easy to use	0.80	
EP34	I needed to learn a lot of things before I could get going with this eP		0.62
EP28	I think that I would need the support of a technical person to be able to use this eP		0.82
EP30	I thought there was too much inconsistency in this eP		0.48

Note. eP = ePortfolio; all values are standardised beta values.

Scale inter-correlations

Of the 36 possible scale inter-correlations, only 10 were statistically significant (Table 5). Only one correlation between eHealth and any of the other ePortfolio values was in this group (i.e., *eHealth*, *time 2* with *ignore* eP assessment; $r = -.37$); this suggests that if students chose to not ignore the assessment aspect of the ePortfolio, their finishing eHealth value was somewhat higher. The *learning* benefits of the ePortfolio were positively correlated with the *assessment* function of improving *group climate*. Likewise, the easiness of ePortfolio, *usability*, was positively correlated with sense of *learning* with eP and *assessment* of eP contributing to positive *group climate*. In contrast, *need help* with the ePortfolio was associated with ignoring the *assessment* function of the eP. Thus, it can be seen that the positive intentions of the ePortfolio are associated with positive *learning*, *ease of use*, and contribution to *group climate*. Unfortunately, only the *ignore* ePortfolio assessment contributed to the *eHealth* scale score and only at *time 2*.

Table 5
Scale inter-correlations

Scales		I	II	III	IV	V	VI	VII	VIII
		Inter-correlations							
eHealth									
I	Time 1	1							
II	Time 2	.30	1						
eP as assessment									
III	Ignore	.08	**-.37***	1					
IV	Group climate	.15	.25	-.06	1				
V	Limitations	-.16	-.19	**.31***	.06	1			
eP usability									
VI	Easy	.15	.29	-.06	**.55****	-.10	1		
VII	Need help	.15	.06	**.35***	.20	-.02	-.05	1	
eP learning									
VIII	Time 1	.23	.03	.09	**.48****	-.26	**.48****	.20	1
IX	Time 2	.28	.28	-.07	**.80****	-.17	**.69****	**.37***	**.71****

Note. eP = ePortfolio; values in bold are statistically significant; $^{**}p < .01$; $^{*}p < .05$

Discussion

This study required undergraduate participants in a health course at the University of Hong Kong to track their daily activity and reflect on their own data in a reflective ePortfolio. Self-reported eHealth literacy increased by the end of the course and the ePortfolio was perceived as being a learning benefit, while the usability was at worst not interfering. In terms of assessment, the students saw the ePortfolio as contributing to a positive group climate: the inter-correlations between scales suggested that eHealth at the end of the course was negatively associated with ignoring assessment within the ePortfolio. In other words, eHealth increased if students paid attention to the assessment function of the ePortfolio. It is important to note that the sample size of this study is rather small; consequently, the current results are tentative. Nevertheless, it would seem that eHealth by the end of the course was relatively independent of the ePortfolio system, except for the importance of its accountability function. Increase in eHealth may indeed have been a function of the personalised AT data, but this was not captured.

Understanding the development and changes of eHealth literacy during the education process at university level seems important for further development of relevant interventions, pedagogical strategies, and policies (Borthwick et al., 2015). An important result in this study was the increased interaction between teacher and student (EP1) and positive endorsement of the ePortfolio as a mechanism for greater learning and more positive group or class climate when using an assessed ePortfolio. We suggest that actual physical health indicators through the AT (i.e., number of steps and sleep hours) could have contributed to greater adoption, initiation, and maintenance of health behaviours.

This study examined self-report survey data concerning ePortfolios and eHealth and identified some factors around students' perceptions of the ePortfolio as a learning tool itself and its usability. However, without a direct measure of actual physical activity from the AT data, it is not possible to show that the AT process actually contributed to learning outcomes or positive evaluation of the ePortfolio system. Nonetheless, without the AT data, the student reflective ePortfolios would not have been possible and the increase in eHealth may be attributable to having the AT data as a learning stimulus.

The increase in the eHealth self-ratings is reassuring. An increase in eHealth might indicate greater insight and understanding, especially if it is reflected in actual improvement in physical activity. Additionally, the requirement to document and record digitally explicit eHealth behaviour and thinking in the ePortfolio seems to have contributed to growth in and explicit attention to actual eHealth literacy. However, research in this field is contradictory; for example, younger students (13- to 14-year-old) identified significant decrease in need satisfaction and autonomous motivation only after 2 months of using a wearable fitness device (Kerner

& Goodyear, 2017). Even if students were dissatisfied with their actual physical activity, this should play out in greater eHealth due to the ability to search for and use digital information about health issues. Hence, it is possible that the use of wearable technology (AT) which conveniently integrates physical activity and social media will have a positive impact upon overall eHealth, if the person judges, based on the AT data, their actual physical health to be unsatisfactory.

A recent study, measuring the eHealth with the same scale (Xesfingi & Vozikis, 2016), demonstrated a positive and strong association between technology literacy and eHealth literacy. However, we found very weak but not statistically significant associations between the ePortfolio technology evaluations and eHealth. It seems likely that the specific ePortfolio technology is a much narrower construct than general technology literacy. Nonetheless, it is much more likely that eHealth may be much more sensitive to perceived health quality in light of AT data, than the technologies used in this study.

Using the AT, students interact with their own real data delivered in real time and anywhere. Such an interaction has a potential learning impact related to the eHealth acquisition, since the students' motivation to be critical about the reading, interpretation, and reliability of health information is based on their own personal experience. While we presume that interaction with personal biometric data stimulates further eHealth behaviour (e.g., searching health information channels for related explanations), evidence for that association is restricted to a negative response to assessment. Nonetheless, that is a clear pointer to future research.

Limitations and future directions

The study has a number of limitations that could be addressed in the future research. The limitation of this study is that eHealth self-rating does not have a clearly identified causal relationship with either the AT or the ePortfolio. We presume that the observed data might be explained by actual physical activity and the student's self-evaluation of the discrepancy, if any, between their expectations and actual physical activity. To address this lack of causality, two additional arms could be added. To answer the question if the students relate the AT data to the health literacy action taken towards the research of related information on the Web or social media, a content analysis of the ePortfolio could be performed. If positively confirmed, this would strengthen the idea of the enhancement of eHealth literacy by using the AT data.

In our study we have observed an increase in self-rated eHealth in undergraduate students after one semester of studies. Is such an increase in eHealth literacy related to personal health? The direct link between eHealth and lifestyle changes has been discussed in a number of studies and the conclusions are contradictory (Xesfingi & Vozikis, 2016). Some studies demonstrated positive correlations, including students' health status and their practice of multiple positive health behaviours, including eating, exercise, and sleep behaviours (Capurro et al., 2014; Hsu, Chiang, & Yang, 2014; Xesfingi & Vozikis, 2016). Others did not find positive association between the eHealth and lifestyle changes (Bodie & Dutta, 2008) and even reported markedly lower actual mean eHealth scores compared to the perceived ones (Hanik & Stellefson, 2011).

Due to ethical constraints within an operational credit-bearing course, we could not measure the lifestyle health effects of our intervention. Future studies should attempt to link actual health data and student perceptions of their activity. Unsurprisingly, much larger sample sizes would go a long way to establishing whether the statistical associations observed in this study are generalisable.

Most of the research related to wearable computing does not come from the field of education (Bower & Sturman, 2015), with few reported exceptions (Alvarez, Bower, de Freitas, Gregory, & de Wit, 2016; Coffman & Klinger, 2015; Saito et al., 2015; Wu, Dameff, & Tully, 2014). Due to the relative recency of wearable technologies with biometric data sensors, there is an obvious lack in research related to the mechanisms behind health action process and eHealth development using these technologies. This could be addressed in the future, possibly in qualitative studies; and as in public health, similar questions could be raised: "What are the objectives of these devices: to monitor, improve performance, accompany behaviour changes, develop empowerment?" (Petit & Cambon, 2016, p. 6).

Finally, the integration of eHealth data and requirements with ePortfolios used for assessment purposes within a course on health results in both positive views of both technologies. This suggests that possibly without ePortfolios different results may have been observed. The need to think critically and analytically with scientific information, in light of one's own data, is an important skill, which the course sought to generate. Testing these combinations in other circumstances (e.g., different courses, different class sizes) might lead to more robust understanding of the joint impact of the ePortfolio and the AT system.

Conclusions

This study has shown that within a health science course the integration of AT and ePortfolio to monitor physical activity has led to positive views of ePortfolios for learning and increasing eHealth self-ratings. In this way, the ePortfolio has fulfilled its promise of meaningful and deep learning through interaction with personal data and the teacher. However, this conclusion is predicated upon the positive impact of having access to one's own personal data in the AT. Without such data, it is unlikely the ePortfolio could have captured significant changes in physical activity or triggered meaningful reflection on personal health. This case suggests one possible effective model of using educational technology with modern wearable technologies for ensuring students achieve deep learning goals as intended by the curriculum in higher education.

Ethics approval and consent to participate

The study has been approved by the University of Hong Kong Human Research Ethics Committee (HREC) for ethical clearance for research involving human participants (nr: EA1601005). Granted Funding: Teaching Development Grant, HKU.

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