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Journal
Assessment & Evaluation in Higher Education, 47(3)

ISSN
0260-2938

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Publication Date
2022-04-03

DOI
10.1080/02602938.2021.1919988

Published in *Assessment & Evaluation in Higher Education* 47 (2021), 375-389,
[DOI: 10.1080/02602938.2021.1919988].

Inculcating curiosity: Pilot results of an online module to enhance undergraduate intellectual virtue

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Abstract

There has recently been a great deal of theoretical interest in the relevance of the intellectual virtues for education, including undergraduate education. This study introduces a novel online module, as part of a larger university-wide initiative, to introduce and potentially inculcate intellectual virtue in students. Using a non-experimental pretest/posttest design, we report pilot results on student satisfaction with the module and gains across several learning outcomes. Results suggest that the module significantly increases scores on student curiosity, knowledge of virtues, and understanding of their importance to education. Moreover, the data suggests that minority and historically underprivileged subgroups do not experience differential satisfaction with the module. This study thus provides preliminary statistical evidence for scaling up this educational resource devoted to inculcating the intellectual virtues. Recommendations for future research are also discussed, with implications for measuring and assessing intellectual virtue, as well as other learning outcomes relevant to higher education.

Keywords: intellectual virtue, higher education, curiosity, learning gains, Bayesian statistics, online education

Introduction

Recent educational work on student intellectual development has appealed to the framework provided by virtue epistemology, which is a theory emphasizing individual attributes in the belief formation process (Hyslop-Margison, 2003; Orona, 2021a). The intellectual virtues are admirable character traits of an individual that are geared towards specifically epistemic goods, like truth, knowledge, and understanding (Zagzebski, 1996; Roberts & Wood 2007; Pritchard, Millar & Haddock, 2010; Baehr, 2011; Battaly 2014). Examples of intellectual virtues include open-mindedness, curiosity, intellectual courage, and intellectual humility. Like virtues more generally, the intellectual virtues involve both a motivational and a skill component (Zagzebski, 1996). It has been argued that a fundamental epistemic goal of education is to develop the intellectual virtues (Pritchard, 2013).

Consider the intellectual virtue of curiosity, for example, which involves being interested in acquiring new information and hence being willing to seek it out via questioning, observation, and so on. It is important to this intellectual virtue both that one is motivated by epistemic goods (as opposed, for instance, to someone who asks lots of question because they enjoy causing annoyance) and that one is skillful in how one undertakes one's inquiries (e.g., simply asking lots of irrelevant questions is not the manifestation of this intellectual virtue) (Ross, 2020).

The importance of the intellectual virtues is partly held to be due to how they enable subjects to be better positioned to pursue and acquire true beliefs (Zagzebski, 1996, Dyer & Hall, 2019; Pritchard, 2019;). As such, scholars have begun to argue for the place of intellectual character development in the wider educational curriculum (Baehr, 2013, 2016; Pritchard, 2013; Barzilai & Chinn, 2018), and specifically in higher education (Battaly, 2006; Heersmink, 2018; Byerly, 2019; Dyer & Hall, 2019; Schwartz; 2020; Orona, 2021a). This line of inquiry centers on

the question of how higher education practices, policies, and pedagogies could be devised to develop epistemically mindful individuals (Carter, 2017; Dyer & Hall, 2019).

However, most of the relevant higher education intellectual virtue scholarship remains non-empirical (e.g., Schwartz; 2020; Orona, 2021a). That is, there are few scientific studies of intellectual virtue among adults (e.g., Leary et al., 2017; Zmigrod et al., 2019; McGrath et al., 2020), and virtually none (to the authors' knowledge) that focus on inculcating these virtues among college-going students. Thus, with the current significance placed on the development of student dispositions, there is a critical need for research aimed at measuring and assessing intellectual virtue in higher education.

In this study, we introduce and evaluate a novel educational intervention designed with the explicit aim of enhancing students' intellectual virtues (in this pilot study, we focus on the virtue of intellectual curiosity). This offers a unique opportunity to evaluate the fidelity and preliminary effectiveness of developing the intellectual virtues within the specific context of university-level education, and thereby fills an important gap in higher education research. It also offers the further advantage of considering how educational interventions of this kind and at this level might function within an online setting. In evaluating the intellectual virtue intervention in the initial phase, we ask the following research questions (RQ):

- RQ1: To what extent are students satisfied with the intellectual virtue intervention module?
- RQ2: Do female, underrepresented minorities, first-generation, and low-income students experience lower satisfaction with the intellectual virtue intervention than their counterparts?
- RQ2: To what extent does participation in the intellectual virtue intervention increase student learning gains in intellectual curiosity, knowledge of the virtues, and their perceived relevance to education?

Description of the module

The intervention is a short, online educational module embedded within courses as part of a larger university-wide project entitled 'Intellectual Virtues in the Curriculum' (IVC). The module has two broad components: (a) introducing and showing the significance of the concept of intellectual virtue, generally, and (b) an explicit emphasis on the virtue of intellectual curiosity. It contains a plethora of pedagogical design features, such as (pre-recorded) videos, engaging exercises, and information on of how the intellectual virtues relate to larger concepts in specific fields. Students received lectures, quizzes (which they were permitted to re-take), and activities on the IVC module to stimulate and potentially stabilize interest in intellectual virtues (i.e., attempting to trigger and maintain students' situational interest in intellectual virtues; Hidi & Renninger, 2006) and inculcate curiosity. Students were to complete the module at their own pace over the course of the term; however, in total, the allotted recorded lecture time—notwithstanding quizzes and activities—was about 2.5 hours of material, separated into 8 mini-modules. Due to space constraints, in Appendix A in the supplementary material, we present detailed information on the specific components of the module, the theory guiding the design of the pedagogical features, quiz items, and figures depicting the general format of the module.

Methods

Context

This study takes place at a large public research university located in southern California with a highly diverse student body. The IVC project is supported by internal funding that is aimed at both introducing and evaluating pedagogical innovation. Internal Review Board (IRB) approval was obtained during spring 2019, which approved the ethics of the student surveys and

study intent. The IVC module was introduced across three different undergraduate courses: 'Introduction to Philosophy' (Philosophy1), 'Introduction to Ethics' (Philosophy4), and 'Frameworks for Professional Nursing Practice' (Nursing110W). All courses except the Philosophy1 were face-to-face courses. The IVC module is completely online and was made available to students as an extra-credit option for the three large lower-division courses in the fall 2019 quarter. There was no penalty for the students who chose to not participate. The module was accessible to students via a hyperlink tab on the course dashboard of the learning management system.

Procedure

Students who opted into the online module were administered a pretest and posttest survey. The surveys took approximately 10-15 minutes to complete. Informed consent was obtained prior to students completing any survey questions. All students were made aware prior to beginning the module of both the purpose of the study and that their voluntary participation can be redacted at any time. Data obtained from the surveys were later compiled with institutional records provided by the Teaching and Learning Research Center at the university.

Participants

There were 602 students with complete institutional data enrolled across the two philosophy and nursing courses. All students were provided with, and completed, a study information sheet that relayed the requirements of the study, the confidentiality agreement, as well as how the results would be used. 264 (44%) students opted into the IVC module. The completion rate was 77% (202 students completed the module). Table 1 displays the means and standard deviations (binary variables are interpreted as proportions) for students without missing data to compare variables across the full, participant, and completer samples. As can be seen,

generally, the means and proportions of student characteristics, academic variables, and major clusters are comparable between the full course sample, participant sample, and the completer sample. All further analysis was performed on the completer sample (those with both pretest and posttest scores).

[Insert Table 1]

Measures

As mentioned, participants were asked to complete a pretest and posttest survey. Satisfaction measures were administered posttest only. Measures that were on both surveys included two curiosity constructs and two other subjective learning gain items, self-reported knowledge of the virtues, and their perceived relevance and importance to the students' education. To measure intellectual curiosity, we administered the 18-item need for cognition (Cacioppo, Petty, & Feng Kao, 1984) and 5-item epistemic curiosity (EC) sub-scale (Litman, 2008). We provide more details and background on these measures below.

Satisfaction measures. Student satisfaction is a common construct utilized in higher education research to evaluate and understand student learning experiences across a range of educational programs and pedagogical innovations (Armbruster et al., 2009; Overbaugh & Nickel, 2011; Lin & Chen, 2016; Doménech-Betoret et al., 2017). It is also widely used to evaluate institutional quality (Alves & Raposo, 2007; Santini et al., 2017). More recently, it is used as an outcome variable to understand the differential experiences of underrepresented minority students (Williams et al., 2018; Miller & Orsillo, 2020). In the present study, we combine these aspects and test whether satisfaction with the IVC module is biased against underrepresented student subgroups.

In this study and during the posttest, students were asked four satisfaction related questions: (S1): *Overall, how satisfied or dissatisfied are you with your experience with the intellectual virtue modules?* (S2): *How effective was the module at introducing you to the concept of intellectual virtues?* (S3): *In comparison to other extra credit opportunities you may have encountered in the past, did you find this module more beneficial in terms of gaining a quality learning experience?* (S4): *How likely are you to recommend this module to friends or colleagues?* Items S1 and S2 were positioned on a 5-point Likert scale, with higher numbers representing greater satisfaction. How likely students are to recommend the module to other students was measured on a slider ranging from 0 to 100, while how beneficial the module was in comparison to other extra-credit opportunities was measured on a 7-point Likert scale. These four questions (S1:S4) were subsequently used in RQ2 as indicators of a latent satisfaction factor.

Subjective knowledge and importance of intellectual virtue measures. The item relating to self-reported knowledge of the intellectual virtues was measured on a 3-point scale with 1 = 'I had never heard of them', 2 = 'I had heard of them, but I couldn't tell you what they are', and 3 = 'I had heard of them and could tell you what they are'. For perceived importance of the intellectual virtues to the students' education, response options included 1 = 'Don't know' 2 = 'Not important', 3 = 'Slightly important', 4 = 'Moderately important', 5 = 'Very important', 6 = 'Extremely important'.

Intellectual curiosity measures. The need for cognition scale (NFC) is an established measure defined as 'one's tendency to engage in and enjoy thinking' (Cacioppo & Petty, 1982, p. 130). The NFC has been used in numerous studies, including those showcasing its mediating role between personality and intelligence (Furnham & Thorne, 2013), as well as positive correlations with college grade-point average (GPA; Elias & Loomis, 2002), standardized test scores (Neigel,

Behairy, & Szalma, 2017) , involvement in co-curricular activities during college (Wang, 2013), and skill acquisition (Day, Espejo, Kowollik, Boatman, & McEntire, 2007). Furthermore, international versions of the NFC have demonstrated similar positive correlations with college GPA (Salama-Younes, 2016). But more pertinent to the present study, NFC has been deemed a widely accepted measure of a desirable global trait that is expected to change over the course of undergraduate education at university. National studies investigating the effects of liberal arts education have used NFC as an outcome of college-going experiences, demonstrating its growth over time and with exposure to key instructional practices (Pascarella, Wang, Trolian, & Blaich, 2013).

The NFC was measured on a 5-point Likert scale ranging from 1 = 'Extremely uncharacteristic' to 5 = 'Extremely characteristic'. The pretest Cronbach's alpha for the NFC was α= .87. The posttest Cronbach's alpha for the NFC was α= .85.

Epistemic curiosity (EC) is a related construct defined as a 'desire for knowledge that motivates individuals to learn new ideas, eliminate information-gaps, and solve intellectual problems' (Litman, 2008, p. 1,586). In this study, we employ the five-item diverse (general) EC subscale. While not as heavily studied as NFC, EC has been related to grades (Eren & Coskun, 2016), among other interest or investment-trait variables (Litman & Spielberger, 2003).

The EC was measured on a 4-point Likert scale ranging from 1 = 'Almost never' to 4 = 'Almost always'. The pretest Cronbach's alpha for the EC was α= .88; the posttest Cronbach's alpha for the EC was α= .91. For both time points, the NFC and EC were moderately correlated. The pretest correlation was r = .50 and the posttest correlation was r = .54.

Data analysis

Analytic plan for RQ1. We answer RQ1 by descriptively examining the means and standard deviations for each of the four satisfaction measures. We look to see—given each response scale—whether satisfaction scores are above the mean response option.

Analytic plan for RQ2. We answer RQ2 with descriptive statistics and with a latent variable structural equation model (SEM). We regress a latent satisfaction construct—using the four satisfaction measures as indicators—on underrepresented minority status, gender classification, first-generation and low-income status. Additionally, we control for Scholastic Aptitude Test (SAT) scores, previous school (either high school or transfer school) GPA, and whether the student is a science, technology, engineering, or math (STEM) major (coded as 1) or not (coded as 0). Due to low cell-size for majors, we only make STEM vs. non-STEM comparisons. Using conventional indices, we also evaluate model fit via evaluating the chi-square test (χ^2), confirmatory fit index (CFI), Tucker-Lewis index (TLI), and the root mean square error of approximation (RMSEA).

Analytic plan for RQ3. For RQ3—our primary research question—we conduct a series of regressions on the four pre-post measures: the two curiosity measures, understanding of the virtues, and the perceived importance to education. For this question, we take a Bayesian approach to data analysis. The distinction with frequentist or classical statistics is primarily situated on the nature of probability, whereby Bayesian epistemologists argue for a personalistic view. On this account, probability is a belief of an individual, not an attribute of an event or object that is discovered in its long-run frequency. Indeed, there are many formal justifications and arguments supporting Bayesian probability in the philosophy of science literature (e.g., Savage, 1972), though they are too removed from the present purposes to recount here. However,

as the philosophical distinction necessarily leads to different procedures and output in the application of common inferential tools, it seems necessary to provide a cursory explanation of Bayes' rule and a very brief summary of the benefits of Bayesian methods.

As a result of the large-scale endorsement among formal epistemologists, as well as increased computational power of modern software, Bayesian methods are slowly beginning to gain popularity in the social, behavioral, and educational sciences (Levy, 2016). Bayes' rule, from which the analytic approach gets its name, is described by the following:

$$Pr(\theta|y) = (Pr(y|\theta)Pr(\theta))/(Pr(y))$$

where θ is a hypothesis or parameter of interest, *y* is the data, $Pr(\theta)$ is the prior belief or prior probability of θ, $Pr(y|\theta)$ is the likelihood, $Pr(y)$ is the probability of the data, and $Pr(\theta|y)$ is the posterior distribution, representing the updated belief about θ, conditional on the data (*y*). The process of applying Bayes' rule is the precise and rationale reallocation of credence; the consequence is an updated belief. For example, an agent with a set of beliefs (prior) encounters evidence (data), those beliefs are updated according to Bayes' rule, reallocating probability mass from some proposition or range of parameter values to other propositions or parameter values, and hence a new probability distribution describing the agent's belief(s) emerges (posterior).

Unlike classical statistics, the primary output is not a point estimate and associated *p*-value, nor is it any other singular test statistic or widely accepted threshold. The primary output of a Bayesian analysis is the entire posterior distribution, which contains all information relevant to one's beliefs about the data, conditional on the data (e.g., Gelman & Shalizi, 2013; Morey, Romeijn, & Rouder, 2013; Kruschke & Liddell, 2018; McElreath, 2020). As priors are an integral

aspect of Bayesian data analysis, we now turn to the construction of the priors as part of the analytic plan.

In constructing our prior distribution for the curiosity measures, we look to several higher education studies assessing change in NFC. Because there are currently, to the authors' knowledge, no comparative studies on the effects of similar online virtue modules to directly inform our prior distribution, our prior is constructed on the basis of the broader college-going literature. For instance, a large-scale study found that one year of college increases NFC by .11 standard deviation units (Seifert et al., 2010), while a .13 and .07 (Pascarella et al., 2013; Castle, 2014) standardized effect has been attributed to different liberal arts experiences. While the timeline for most of these studies focuses on a year or more worth of college, our study's timeline is one academic quarter. Naturally, this would decrease the magnitude of change anticipated in the curiosity measures. However, each of the independent variables in the listed studies represent broad college-going experiences that are not explicitly intended to inculcate curiosity. The IVC module, in contrast, is explicitly designed to develop students in intellectual virtue, and specifically curiosity, and therefore a larger effect than previous studies—despite the shorter time period—is anticipated, yet the limits of this effect are constrained by previous knowledge. Thus, we represent our prior beliefs about the (standardized) effect of the IVC module as normally distributed with a mean of .13 and a standard deviation of .1, reflecting our uncertainty about the module's association with the two curiosity constructs (NFC and EC).

Below we display the full model with a dummy-coded IVC variable (0 = pre-module and 1 = indicating post-module):

$$Y_t \sim Normal(\mu_t, \sigma)$$

$$\mu_t = \alpha + \beta_1(IVC)$$

$$\alpha \sim Normal(0, 2.5)$$

$$\beta_1 \sim Normal(.13, .1)$$

$$\sigma \sim Exponential(1)$$

where Y_t represents the outcome (NFC or EC) for every time-point *t*; α is the constant; β_1 is the parameter representing the effect of the dichotomous IVC variable comparing pre and post module scores (1 = post-module).

For the subjective gain measures, Y_t represents understanding of the virtues and the perceived importance to education, and the curiosity model structure remains largely intact, only with different priors. Here, we stipulate larger effects (and more uncertainty), since students are not routinely exposed to intellectual virtues or taught their connection to education (Hyslop-Margison, 2003; Baehr, 2016). Thus, we anticipate the effect of the IVC module (β_1) on these two outcomes to be normally distributed with a mean of 1 and standard deviation of .5.

Results

RQ1: Satisfaction and enjoyment of IV curriculum

Table 2 displays the overall statistics for each of the four satisfaction variables. We find that, for all four variables, satisfaction was well above the middle response point. Additionally, every subgroup examined displayed mean scores above the mid-point response of the scales.

Finally, although only descriptive, the small standard deviations for each measure and across subgroups is also suggestive of the high-level of satisfaction with the IVC module.

[Insert Table 2]

RQ2: Equitable satisfaction and enjoyment of IV curriculum

Table 2 provides descriptive evidence showing that not only is satisfaction generally high, but that differential satisfaction across subgroups is also minimal. To formally test these differences, we present figure 1 showing the results of the SEM model, which fit the data well across multiple indices ($\chi^2 = 49.61$ (26), $p < .01$, CFI = .941, TLI = .914, RMSEA = .066). Figure 1 displays two relevant features of the SEM model, starting from left to right: (a) The estimates for the variables used to predict the satisfaction with IVC module factor and (b) the factor loadings of the four satisfaction indicators (S1:S4) on one latent satisfaction factor. While the four satisfaction indicators each exhibited high loadings (well above .5), the latent satisfaction variable was not significantly predicted by any of the four subgroups of interest, after controlling for prior ability and major, $p > .05$.

[Insert Figure 1]

RQ3: Learning gains

Table 3 displays the summary of the posterior distribution and convergence diagnostic of the IVC parameter for each of the four outcomes. Both subjective gain measures exhibited larger posterior means than the two curiosity measures. The importance of IV to education had the largest posterior mean with .75. Of the two curiosity measures, NFC had a larger posterior mean of .18. The convergence diagnostic shows a value of 1, indicating that posterior chains are well mixed for all models.

[Insert Table 3]

To visualize this updated belief about the IVC module's association with NFC, we turn to the top pane (a) of figure 2. Here, the left most distribution represents our prior belief about the effect of the IVC module on NFC before seeing the data which, as stipulated in the methods section, is represented as normally distributed with mean of .13 (indicated by the vertical line) and standard deviation of .1. The right most dotted outline represents the likelihood function for this parameter, also described as the information obtained from the data. The solid middle distribution is the posterior distribution, which here is clearly displayed as a product of the prior and likelihood. We see that the information obtained from the study data has shifted our belief about the IVC effect size to the right (i.e., placing greater density over larger positive values), though our prior belief is doing work in tempering the reallocation of credence over plausible parameter values.

[Insert Figure 2]

Similarly, the bottom pane (b) of figure 2 shows the prior, posterior, and likelihood of IVC parameter (IVC effect size) in the EC model. Using the same prior as we did for the NFC model (M = .13, SD = .1), we see that the posterior shows only a marginal shift away from the prior, with all distribution outlines in the figure very close together. The posterior displays a tighter distribution, increasing our confidence that that the mean effect size is near .13.

The bottom pane (b) of figure 3 shows the prior and posterior distribution for the IVC parameter in this model. We see that our belief IVC effect size has also shifted downward, as we reallocate credence over plausible parameter values. Here, our posterior shifts away (downward) from our prior towards lower parameter values.

[Insert Figure 3]

Discussion

In line with the growing interest in a virtue epistemic pedagogical framework and the newfound salience placed on non-academic metrics in higher education (e.g., Fagioli et al., 2020), the purpose of this pilot study was to provide preliminary evidence of the effectiveness of an online intellectual virtue module. As these pilot data indicate, students generally reported high levels of satisfaction with the IVC module. Additionally, our second set of findings suggest that a negative student experience with the module is likely not a function of membership in historically underrepresented and underprivileged groups. Given concerns with providing equitable educational programs and pedagogies that appeal to and resonate with a diverse student body (Orona, 2021b), we view these results as promising.

Our third set of findings suggest that students exhibit learning gains across all four measures. First, for the curiosity measures, the posterior means representing the standardized effects were larger than the point estimates reported in previous studies examining college or college-going experiences. Unlike other effects on NFC found in previous studies (e.g., Pascarella et al., 2013), we observed a shorter time period yet observed a larger effect size. But this was largely anticipated; previous studies were not tailored interventions to increase curiosity, but rather evaluations of the effects of broad college-going experiences.

Furthermore, students' self-reported claims about their knowledge and understanding of the value of the intellectual virtues sharply increased, showing preliminary evidence that students perceived the module as effective in initiating them to the intellectual virtues and drawing their connection to education. Though deploying objective longitudinal measures, including unique

forms of performance assessments and in-depth interviews, constitutes a more robust scheme for assessing growth, self-report is commonly used to assess affective, behavioral, and cognitive learning gains in higher education research (Rogaten et al., 2019).

One obvious contention to this finding is that the current design does not control for time effects. That is, for example, we cannot rule out the possibility that the growth in curiosity is the result of natural maturation undergraduate students undergo during the quarter. Though, there are several features of the analysis that are important to highlight for the purpose of understanding this potential source of bias. Using the NFC findings to illuminate these points, if the observed effect size was *only* attributed to maturation, we would expect a much smaller posterior mean value of approximately .04, if not even smaller (see analytic plan section for RQ2). Second, we used Bayesian priors informed by previous literature. The research-based priors serve to adjust our posterior in accordance with expectations derived from similar studies, thereby regularizing the posterior mean. In this study, and as seen in figure 2, the prior is in fact adjusting our posterior *away* from the likelihood (representing information in the data) towards smaller parameter values. This means that, had we not incorporated informative priors, our posterior mean (or ordinary least squares/maximum likelihood estimate) would have been larger than the reported .18 for NFC.

Limitations and future directions

Even though our priors circumvent the full force of maturation effects, our results cannot be interpreted as causal. The many weaknesses of a one-group pretest/posttest design are well documented (e.g., Shadish, Cook, & Campbell, 2002); still, these designs are useful in examining implementation, experimenting with new measures, and providing preliminary evidence to support further studies exhibiting more robust study design features. Given the early stage of the

module, and the exploratory nature of this initial pilot design, the results from this study can be viewed as preliminary evidence in support of designing a more rigorous IVC evaluation study. Specifically, researchers scaling up the IVC module could evaluate the effects of participation using a randomized control trial where students are randomly assigned to the IVC module within courses. Finally, it would be useful to expand the IVC module to inculcate other intellectual virtues beyond curiosity—such as intellectual humility—and to seek other forms of assessment.

Conclusion

Higher education is placing increased salience on developing students in a diverse array of skills and dispositions. In line with these developments, the concept of intellectual virtue is beginning to transition from the philosophical literature to empirical assessment in higher education contexts. Concomitantly, with the threat of the COVID-19 virus, higher education is seeing a full transition to online and distance education. The lack of personal connection and traditional opportunities for extra-curricular engagement activities pose challenges to the development of many desirable dispositions. Accordingly, this study was the first, to the authors' knowledge, to introduce and evaluate an online curriculum module developed to inculcate intellectual virtue in university students. In summary, the high level of satisfaction, consistent enjoyment across important student subgroups, and large growth on measures of curiosity and self-reported knowledge and value of intellectual virtue, suggests a robust set of preliminary evidence in support of scaling up the IVC module and conducting further research. Provided the significant changes required for higher education to prioritize habits of mind over success metrics, such as administrative and institutional buy-in (Baehr, 2016), the IVC module may potentially offer educators a feasible, cost-effective means of developing intellectual virtue without relying on a system overhaul.

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